RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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GENERAL INFORMATION

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Robert S. Stone, M.D.
Carman Lecturer, 1952

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The Concept of a Maximum Permissible Exposure

Carman Lecture[1]

ROBERT S. STONE, M.D.[2]

San Francisco, Calif.

MR. PRESIDENT, members of the Radiological Society of North America, and guests, it is a great honor and a great responsibility to be selected to give the Carman Lecture. The choice of the Carman lecturer is one of the privileges and duties of your president. When Doctor Bouslog asked me to accept this responsibility, he asked that I report to you on some aspect of the radiological work of the Metallurgical Project—the project that was concerned with chain-reacting piles and producing plutonium. Reports of many specific research activities have already been made, notably those included in the plutonium symposium before this society in 1946. Instead of reporting specific experiments, I decided to discuss one of the biggest problems we had to face in the Health Division of the Plutonium Project and one which you must face every day; namely, to what amount of ionizing radiation may a person be exposed day after day without detectable damage to himself or future generations.

Radiologists as a group have been content to accept the decisions of the national and international committees and commissions with regard to the maximum permissible exposure. In this lecture I will present to you some clinical and experimental data that will help you to form your own concept of a maximum permissible exposure. The word "concept" applies to the idea of a thing which the mind conceives after knowing many related facts. The facts needed are the results of chronic exposures of men and animals to ionizing radiations. The expression "maximum permissible exposure" means the largest exposure in any selected time period, such as a day or week, to which you are willing to permit yourself or anyone else to be exposed repeatedly. This was formerly called the "tolerance dose."

This annual lecture is to honor the memory of Russell D. Carman. It was suggested to me that it would be an original approach to give a memorial lecture without in any way connecting the subject with the person being memorialized. That approach cannot be used tonight because Doctor Carman was a man of broad interests in the field of radiology. In this city, in 1924, he read a paper (13) before this society on the occupational hazards

[1] Delivered before the Radiological Society of North America at the Thirty-seventh Annual Meeting, Chicago, Ill., Dec. 4, 1951.

Some of the work on which this lecture is based was done in the Metallurgical Project of the University of Chicago, financed by the Manhattan District U. S. Engineers. Recently, partial support has come from the Atomic Energy Commission, Contract AT-11-1-GEN-10, Project 2, which supports the Radiological Laboratory.

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TABLE I: HISTORICAL LANDMARKS: RADIATION INJURIES

1895 (Dec. 28)	Announcement of discovery of x-rays	Roentgen
1896 January	X-ray dermatitis of the hands	Grubbé
March	Smarting of the eyes	Edison
April	Epilation without dermatitis	Daniel
1897 (February)	Twenty-three cases of x-ray dermatitis reported	Gilchrist
	Constitutional symptoms reported	Walsh
1898	Paraplegia and spasmodic muscular contraction	Rodet and Bertin
	Roentgen Society (British) started to collect information on injurious effects of roentgen rays	
1899	Degeneration of vascular endothelium reported	Gassman
1901	Guinea-pig killed by x-rays without "burn"	Rollins
1902	Cancer developed in chronic x-ray ulcer	Frieben
1903	Bone growth inhibited in animals	Perthes
	Sterilization of male rabbits and guinea-pigs	Albers-Schönberg
1904	Changes produced in blood of rabbits	Milchner and Mosse
	Leukopenia caused by x-rays in mammals	Heineke
1905	Lymphocyte shown as most sensitive leukocyte	Helber and Linser
1906	Bone marrow changes demonstrated	Warthin
1910	Tumors produced in skin of rat	Clunet
1911	Ninety-four cases of x-ray induced human tumors	Hesse
1912	Anemia found in two x-ray workers	Béclère

of the radiologist. While he did not talk about tolerance dose or maximum permissible exposure, he did discuss the effects which make it necessary for us to establish what is tolerable. It is fitting, therefore, that this topic be the subject of a memorial lecture to that great radiologist.

* * * * * * *

Shortly after x-rays were discovered, some of those who worked with them were injured. The need for means of protection was obvious. It was recognized that to get complete protection while still using these rays, and the gamma rays from radium, was almost impossible. Scientists have tried, therefore, to find a rate of exposure which could be tolerated. Let us follow this historical sequence of events (Table I) while attempting to form a concept of a maximum permissible exposure.

Roentgen submitted his first paper announcing the discovery of x-rays on Dec. 28, 1895 (85). Before the end of January 1896, Grubbé (33), at that time a manufacturer of vacuum tubes, presented himself to his physician at the Hahnemann Medical College, Chicago, with a peculiar dermatitis of the hand which both the patient and the doctor considered to be due to exposure to the roentgen rays. In March of that same year, Edison (21), who was experimenting with fluoroscopes, reported soreness of the eyes following exposure to the x-ray machine. In April, Daniel (19) reported epilation of the scalp, and in succeeding months of that year more reports of damage were made by different observers. By February of 1897, 23 cases of x-ray dermatitis already had appeared in the literature (28), and others had undoubtedly occurred that were not published. In that same year, Walsh (92) described constitutional symptoms from x-ray exposure. In 1898, Rodet and Bertin (80) reported paraplegia and irregular and spasmodic muscular contractions in two patients, indicating an effect on the central nervous system. The Roentgen Society (British), in that same year, started "to collect information on injurious effects of roentgen rays" (84). In 1899 the degeneration of vascular endothelium was described (27). In 1901, Rollins (83) showed that it was possible to kill a guinea-pig by x-rays without any superficial burn appearing on the body of the animal. In 1902 appeared the first report (26) of a cancer developing on the site of a chronic x-ray-produced ulcer. In 1903, Perthes (78) showed that the growth of bones of young animals could be inhibited by exposing the ends to radiation, and in the same year, Albers-Schönberg (1) showed that sterilization of

male rabbits and guinea-pigs was possible. In 1904, the changes produced in the blood of rabbits and other animals by radiations were demonstrated by Heineke (34) and by Milchner and Mosse (66). In 1905, Helber and Linser (35) showed that the lymphocyte was the most radiosensitive leukocyte. In 1906, Warthin (93) demonstrated changes in the bone marrow following exposure to radiation. In 1910, Clunet (15) showed that he could produce tumors in the skin of rats by exposure to radiation. In 1911, Hesse (40) collected 94 cases of tumors presumed to be the result of exposure to ionizing radiation. In 1912, Béclère (6) reported anemia in two x-ray workers.

It is thus clear that many harmful effects of irradiation were known very early in the history of the use of x-rays. It is also true that in his first paper, Roentgen (85) discussed the ability of materials to absorb the rays and showed that heavy metals were very effective. Some of the early workers protected themselves sufficiently so that they were not harmed. There were, however, no organized efforts to promote methods of protection until 1915. In that year the Roentgen Society (British), after listening to a paper on protective devices by Russ, decided to do something about protection. In London, in November 1915, it issued its "Recommendations for the Protection of X-ray Operators" (48). These recommendations showed an understanding of the chronic effects of x-rays and of the need of lead protection, but evidenced no concept of a "tolerance" dose.

By 1922, Ledoux-Lebard (55) estimated that more than 100 of the pioneers in radiology had died from cancer caused by their occupation. This fact and the then currently reported deaths from aplastic anemia aroused anew the press, the public, the insurance companies, and those directly concerned, to the dangers of radiations. In 1921, the British X-ray and Radium Protection Committee was formed and issued its first report (10). In the following year there appeared a report from the American Roentgen Ray Society on radiation protection. Each of these reports dealt with protection, with no hint of considering any amount of radiation as tolerable. Kaye (49) tells us, however, that the British X-ray and Radium Protection Committee in their discussions considered "establishing a maximum tolerance dose in terms of a specifiable and reproducible biological standard, and if possible expressing this biological standard in physical units." In 1928, the International Committee on X-ray and Radium Protection was formed and adopted rules regarding protection (45), but they formulated no concept of a tolerance dose.

TABLE II: HISTORICAL LANDMARKS: PROTECTION—TOLERANCE

1902	Rollins photographic indication of "safe" intensity
1915	Roentgen Society (British) recommendations on protection
1919–21	Mounting number of deaths of radiation workers from cancer and aplastic anemia
1921	British X-ray and Radium Protection Committee Report on Protection considered "establishing a maximum tolerance dose"
1922	American Roentgen Ray Society adopts rules on radiation protection
1925	First attempt at establishing a "tolerance dose" by Mutscheller
1928	First International Committee on X-ray and Radium Protection—recommendations on protection but no tolerance dose
1931	U. S. Advisory Committee on X-ray and Radium Protection recommends tolerance dose of 0.2 r per day
1934	International X-ray and Radium Committee endorses tolerance dose of 0.2 r per day
1936	U. S. Advisory Committee reduces tolerance dose to 0.1 r per day
1942	Metallurgical Project adopts tolerance dose of 0.1 r per day
1950	International Commission on Radiological Protection recommends 0.3 r (air) per week = 0.05 r per day

In 1931, the Advisory Committee on X-ray and Radium Protection of the United States (91) and, in 1934, the International Committee on X-ray and Radium Protection (45) both endorsed a tolerance dose of 0.2 r per day. Neither committee gave any description of their concept of a tolerance dose.

The first reference I found to a tolerance dose was by Rollins (82) in 1902 (Table II). He stated that if a photographic plate is not fogged in seven minutes, the radiation is not of a harmful intensity. The first clearly stated idea of a tolerance

TABLE III: ESTIMATION OF TOLERANCE DOSES

Date	Author	1/1000 Erythema Dose in Days	Calculated r per Day
1902	Rollins	(Photographic)	10
1925	Mutscheller	3	0.2
1925	Sievert	3	0.2
1926	Solomon	0.3	2.0
1927	Dutch Board	15.0	0.04
1928	Barclay and Cox	3.5	0.17
1928	Kaye	5	0.12
1931	Advisory Committee (U. S. A.)	..	0.2
1932	Failla (γ rays)	30.0	0.1*
1932	Stenstrom	3.7	0.16
1936	Advisory Committee (U. S. A.)	..	0.1
1950	Internat. Commission	..	0.05†

* Failla says gamma ray erythema = 1,800 r. Other calculations on erythema = 600 r.

† I. C. R. P. recommended 0.3 r (air) per week.

amount of radiation is found in the writings of Mutscheller (71), who stated, in 1925: "But there is still a third question for, in order to be able to calculate the thickness of the protective shield, there must be known the dose which an operator can, for a prolonged period of time, tolerate without *ultimately* suffering injury." He arrived at a definite tolerance dose by surveying some typical installations where a limited number of operators had worked with no apparent damage, and calculating the dose to which those operators had been exposed during a period of one month. The survey was made with an ionization chamber and the rate of discharge was related to the "erythema dose." Mutscheller goes on to say: "It is entirely safe if an operator does not receive every thirty days a dose exceeding 1/100 of an erythema dose. From the present status of our knowledge this seems to be the tolerance dose for all conditions of operating roentgen ray tubes for roentgenography, roentgenoscopy, and therapy." This dose is estimated to be equal to approximately 0.2 r per day (Table III).

In 1928, Barclay and Cox (3) published their idea of a safe limit for daily exposure based on the investigation of the radiation received by one doctor and one operator. They determined what percentage of a unit skin dose these two had received and then added a generous factor of safety. By related means, Sievert in Sweden, Solomon in France, and the Dutch Board of Health in the Netherlands established various tolerance doses. Kaye (49), reviewing them all in 1928, took an intermediate value of five days as the time during which 1/1000 of an erythema could be received and still be within the "limit of safety." If we assume that an erythema is produced by an exposure of 600 r, then Kaye's dose was 0.12 r per day. In 1932, Failla (24), discussing radium protection, defined tolerance dose as follows: "We may now define the safe upper limit of the tolerance dose or simply the 'tolerance' dose as that dose of radiation which experience has shown to produce no permanent physiological changes in the average individual." He measured the radiation that had been received by radium technicians at the Memorial Hospital (New York) and came to the conclusion that they had received 1/1000 of a threshold erythema per month without harmful effect. He did not translate this into roentgens because the gamma roentgen was not established at that time. Since then he has stated that it takes 1,800 r of radium gamma rays to produce an erythema. Hence, his tolerance dose would be about 0.1 r per working day.

In 1936, the United States Advisory Committee reduced the recommended tolerance dose to 0.1 r per day without any written explanation. Information from committee members indicates that this was done because it was felt that with the more penetrating radiations from higher-voltage machines coming into more general use, a smaller surface dose was necessary to keep the tissue dose in the hemopoietic tissue at the same level as when less penetrating rays were used. They were thinking of the hemopoietic tissue as a critical tissue.

The British protective committees have made frequent reference to: "(*a*) injuries to the superficial tissues, and (*b*) changes in the blood and derangement of internal

organs, particularly the generative organs," as the effects to be avoided.

In 1942, the first nuclear chain-reacting pile was built. Its success initiated the planning of more powerful units and of large-scale radiochemical works. The protective measures had to be calculated on the basis of the "established" tolerance dose and it was all too clear that the scientific data on which that was based were very limited. Since 1942 many thousands of people have been and still are potentially exposed to ionizing radiations. A great increase of interest and investment of time, manpower, and money in the biological effects of radiations has come about. The expression "tolerance dose" has been dropped because no one could say that any amount of radiation is tolerable over a lifetime. The more realistic expression "maximum permissible exposure" is now in use. Direct observation and monitoring of potentially exposed personnel were established on a very large scale, and experimentation with lower animals was started on a scale not known before in an effort to establish a tolerable dose of radiation. More attention was given to determining what effects were to be seen from chronic exposures.

In 1950, the International Commission on Radiological Protection (44) listed the effects to be considered more completely than had been done before by any committee or commission. Their list is as follows:

1. *Superficial injuries.*
2. *General effects on the body, particularly the blood and blood-forming organs; e.g., production of anemia and leukemia.*
3. *Induction of malignant tumors.*
4. *Other deleterious effects, including cataract, obesity, impaired fertility, and reduction of life span.*
5. *Genetic effects.*

Before proceeding to review what has been found in recent years about these specific effects, let us stop to consider in general terms the effects that ionizing radiations are known to produce on cells.

It is moderately well established that the energy of x-rays is transferred to the atoms and molecules of tissue by ionization and excitation, and that these processes result in chemical changes within the protoplasm. The following intracellular effects of radiation, and many others, are now fairly well established: changed radicals of numerous types; formation of varied peroxides and other oxidation products, both stable and unstable; alteration of the states of polymerization; alterations of the degree of viscosity; denaturation of proteins; inactivation of enzymes; changes in the genes; chromosome breaks and rearrangements; stickiness of chromosomes; delays of mitosis; and alteration of various other physiological processes.

TABLE IV: EFFECTS OF SMALL SINGLE DOSES

Dose in Roentgens	Effect	Observer
0.001	Natural radiation *plus* cosmic rays	Sievert
0.001	Change in growth rate of single cell of *Phycomyces blakesleeanus*	Forssberg
0.005	Change in time of life cycle of *Drosophila melanogaster*	Sievert
0.1–1.0	Inactivation of catalase enzyme	Forssberg
1.0	Decreased liberation of phosphorus-myosin (aged)	Barron
5.0	Inhibition of mitotic activity in skin	Knowlton and Hemplemann
5.0	Threshold for mitotic effect in grasshopper neuroblast	Hollaender
25	Threshold for recognizable reduction of lymphocytes in animals	Jacobson
50	Minimum dose showing injury to lymph nodes	Bloom

While it is true that many of these effects are produced only with high dosages, some changes can be detected from very low dosages (Table IV). Forssberg (25) has detected changes in the growth rate of single cells of *Phycomyces blakesleeanus* with a dose of 0.001 r, which is about the same amount of radiation as the combination of cosmic rays and natural radiation. Sievert (88) has observed changes in the time of the life cycle of *Drosophila melanogaster* with a dosage of 0.005 r, or just five times that of the natural radiation. Forssberg was able to inactivate catalase

enzyme with as little as 0.1 r. Barron (5) demonstrated a decreased activity of aged myosin with as little as 1.0 r. These effects are produced by doses that are near to and even below that considered as the maximum permissible exposure. To produce microscopically visible changes, such as the inhibition of mitotic activity in cells of the skin of the mouse (52), and in the neuroblast of the grasshopper (41) requires many times the daily tolerance, namely, 5 r. To produce a reduction of lymphocytes in the circulating blood (47) requires about 25 r, and yet this was considered a very sensitive reaction. In order to damage lymph nodes so that the changes can be detected histologically many times the maximum permissible exposure is necessary (8).

Our concern with regard to ultimate damage to an individual is with changes caused by small doses of radiation that are irreversible from the beginning or that, because of cumulative effects, become irreversible. In this relation, there are two main concepts of the biological action of ionizing radiations (31) that interest us. The first has to do with the so-called "target theory," which explains certain radiation effects on the assumption that the ionization occurs in, or in the immediate neighborhood of, certain molecules which constitute a vital target. This type of reaction is independent of the dosage rate or the fractionation of the dose and the effects are totally cumulative. From this type of effect there is no recovery of the cell or the intracellular organs once the vital target has been hit. Gene mutations are the best understood example of the target theory.

The other concept is related to the "intracellular poison" theory, which holds that certain radiation effects are brought about by chemical changes produced almost anywhere within the cell. An example of the action explainable on the intracellular poison theory is the temporary inhibition of mitosis. This has been demonstrated in the epidermal cells of mice by Knowlton and Hempelmann (51, 52), as a result of exposures as low as 5 r. The effect appears in one and a half hours, and recovery sets in soon after. Koller (53) believes that the inhibition is due to a blocking of the process of reduction of ribose to desoxyribose nucleic acid.

We must not forget that gene mutations and structural changes in the chromosomes can occur in somatic cells as well as in germ cells, and the gradual accumulation for years of altered cells among those responsible for replacements may be the cause of visible changes. Muller (70) believes that genetic changes in the somatic cells are the source of most of the delayed and chronic injuries of tissues and of the body as a whole.

From the above considerations, it is obvious that reversible and irreversible reactions do occur within cells with both minute and large doses of ionizing radiations. In addition to these, there are alterations in the intercellular substances. The combination of intra- and intercellular changes results in the chronic effects on tissues and organs that are of vital interest to us.

SUPERFICIAL INJURIES

Acute superficial injuries of the skin and subcutaneous tissues were the first damaging effects to be noted after the discovery of roentgen rays. It was relatively easy to connect effect and cause in the case of such acute changes. It took some years, however, for the early workers to realize that damage was occurring even though no changes were observable for a long time. All radiologists know now that there may be a long latent period before the results of small daily doses are visible, but many do not realize how long that latent period may be.

A radiologist acquired a new fluoroscopic table in 1915. The x-ray tube had no built-in protection, but was enclosed in a wooden box which was supposed to be lined with lead. Five years later, in 1920, when this radiologist moved his office he found that part of the lead lining had been omitted, so that his right foot,

which was frequently under the table, must have been exposed to radiation. He noticed no effect on the foot until 1946, twenty-six years later, when the skin began to crack and the nail of the big toe to break. When we saw him in 1947, a complicating epidermophytosis was present, but it was possible to recognize the thin, scaly skin with some telangiectasia and marked changes in the nails characteristic of radiation damage. Unfortunately, we do not have any idea how much radiation his foot received.

In attempting to form a concept of what is the maximum permissible amount of radiation to be received by the skin, we find ourselves hopelessly lost because of the lack of knowledge of the dose received by the great numbers of radiologists, physicists, engineers, and others who sustained injuries in the past. Parker (74, 75) reports that he saw changes on the hands of personnel working with radium who according to his measurements received as little as 4 r per week to the skin. A much greater effort is now being made to measure accurately the radiation received on the hands as well as on the total body. Thus Wilson (94) has reported that the fingers of workers engaged in radium mold work received 4.7 r for every 50 milligram-hours of active work, even though the work was done in a specially made protective chamber. The back of the hand received 1.25 r, the forehead 0.415 r, and other structures much less. No changes had been observed, but these doses had been received for relatively short periods of time, such as two years. It will be of great importance to have a report on those workers fifteen years from now. If more measurements of the actual doses received on the skin of those working with ionizing radiations are made and the personnel observed over a prolonged period of time, it will be possible in ten or fifteen years to obtain a better idea of what is permissible.

It should be recognized that the overexposure of an area of skin, regardless of size, is just as likely to result in changes as the exposure of all of the skin of the body. In the case of the hemopoietic system, the destruction of one part might be compensated for by proliferation of another but there is no mechanism whereby one part of the skin can compensate for another except by surgical interference.

In an attempt to determine a tolerable dose to the skin of man, Sievert (88) took Strandquist's fractionation curve for erythema dose and extrapolated it for much longer periods of time. By such a method he found that the erythema dose would be 6,000 r if delivered in three years, or 10,000 r if delivered in thirty years. When he took account of the very large fields (whole body), he concluded that the daily dose needed to produce an erythema might be 3 r per day for a three-year period, and 0.5 r per day for a thirty-year period. Sievert calls the minimum dose which causes a scarcely perceptible biological effect of a certain type the "active tolerance dose," and the maximum dose which should be allowed for persons engaged in radiological work the "safety tolerance dose." The *safety* tolerance dose should be one- or two-tenths of the active tolerance dose. He feels, however, that, because of the uncertainties involved, a tolerance dose of 0.1 to 0.5 r per day could be set.

To obtain experimental information about the effect of small daily doses of radiations over a prolonged period of time, mammals should be so exposed, yet prior to 1942 few really long-term experiments had been carried out except those by Lorenz and associates (56) at the National Cancer Institute. Since 1942, several groups of scientists have started chronic experiments. Since I will want to refer to them frequently, I will mention the kinds of experiments here and later refer to them by location: 1. National Cancer Institute; 2. Chicago; 3. Rochester; 4. Oak Ridge.

Lorenz and associates (56, 58, 59, 60), at the National Cancer Institute, exposed mice, guinea-pigs, and rabbits to gamma rays from radium for eight hours or twenty-four hours daily, seven days per week, giving daily doses of 0.11 r, 1.1 r, 2.2 r, 4.4 r, and 8.8 r for the life time of the

animal. At Rochester, Dowdy and his staff (4, 43, 65) exposed rats, rabbits, and dogs to x-rays produced by 250-kv. and 1,000-kv. apparatus for short periods daily, six days per week, giving doses of 0.1 r, 0.5 r, 1 r, and 10 r per day. Cole and associates (16), at the Metallurgical Laboratory of the University of Chicago, used various animals to compare the effects of x-rays and neutron beams. In the Clinton Laboratories at Oak Ridge, Curtis, Zirkle, and staff (18, 39, 79, 95) used pile radiations and those from radioisotopes in various ways.

Returning to a consideration of effects on the skin, at the National Cancer Institute no gross evidence of changes was found even in the animals irradiated at 8.8 r per day for their lifetime. The total doses received by some animals were: mice 5,800 r; guinea-pigs 6,000 r; rabbits 12,000 r. Snider (89) studied histologically the skin of some of the guinea-pigs after eighty-two days during which they had received 8.8 r per eight-hour day and reported that in 50 per cent of the animals examined he found a thickening of the epidermis amounting to 25 per cent, and beneath this were small areas of mild edema in the dermal tissues. Thus it would appear that 8.8 r per day is not without some effect on the skin of the guinea-pig.

At Rochester (65) no skin changes were noted, but it should be pointed out that many of the animals exposed at the rate of 10 r per day died during the experiment and the others were followed for only about two years.

At Oak Ridge the animals irradiated with beta rays from P^{32}, at the rate of 5 rep per day, for nineteen months showed no changes in the skin (79, 95). The mice that received 50 rep per day showed a diffuse slight epilation over the head and trunk and occasional superficial ulcerations. The rats showed no epilation or ulceration even at this higher dosage.

In summary, you must form your concept of a maximum permissible dose for the skin from the following information: 1. Many persons have sustained damage to the skin with unknown doses. 2. Parker saw skin changes from doses of less than 1 r per day (4 r per week). 3. Sievert calculates a safety tolerance dose as between 0.1 and 0.5 r per day. 4. The minimum known to produce changes in guinea-pigs' skin is 8.8 r per day (eight hours); other animals showed no changes at this level, but the animals live only about three years!

EFFECTS ON THE BLOOD AND HEMOPOIETIC TISSUE

Ever since 1903, it has been known that radiation affects the blood and blood-forming organs. The problem has been to determine what changes are significant and how small a dose will produce them.

The literature is full of descriptions of blood counts of people exposed, or potentially exposed, to radiations; but unfortunately, few of the reports help us, since too little was known about the amount of radiation exposure. Carman (13), in 1924, showed from the literature the great variations in the response of the blood to radiation, and reached the conclusion that there was proof that it was affected, but no proof that it was affected in the same way in different individuals. That there was an effect had been well brought home to radiologists of that time by the deaths from aplastic anemia of an Italian, an English, and a Danish radiologist. An American had been near death's door but had recovered.

A great deal of the literature on blood changes refers back to the work of Goodfellow (32), who carried out one of the most careful studies of the blood of persons working with radium. The workers he studied must have had a considerable amount of exposure, since he describes the other changes, that may or may not appear with the blood changes, as "lassitude, disinclination to work, hypopiesis, and erythema of the hands." He concluded, after a study of these individuals, that there is only one sign of early overexposure which is common to all workers—leukopenia due to a reduction in the number

of circulating neutrophils. He points out, however, that in some cases there is a lymphocytosis, in some cases an eosinophilia, in some a monocytosis, while in some abnormal or embryonic leukocytes are seen. Paterson (76), in discussing a follow-up of Goodfellow's work, showed that, when the conditions of work were improved so that less radiation was absorbed by each worker, the blood counts of all became more normal. In 1943, Russ (86) tried to establish normals for different elements of the blood by the questionnaire method, and found that he got as many opinions as to what was normal as there were doctors who answered—and the variations were not small.

In Sweden, under the Roentgen Ray Protection Law of 1941, all areas where ionizing radiations are used must be surveyed as to the built-in protection and the mental attitude towards protection. Blood counts must be made annually on all personnel working with radiations. In 1946, the working areas and blood counts were reviewed by Helde (36) and Nordenson (73). They found, when they classified the various premises where x-rays or radium were used (medical and dental offices, hospital departments, industrial installations, etc.) into four classes according to the "riskiness" of the working conditions, and grouped together the blood counts of all the workers in each of the four different risk groups, that those in the most risky places showed the greatest alterations in the blood counts. Hypersegmentation of the neutrophils, granulocytopenia, the appearance of pathological lymphocytes, and the "shift to the left" were found to be the most definite indicators of bad conditions in roentgen establishments. Unfortunately, these observers dealt with the differential white counts in percentages rather than in absolute numbers, making it difficult to tell whether what they called a lymphopenia was a real or a relative decrease in lymphocytes. Nordenson believed that he could detect two types of changes in the blood, one which he called "reactive and reversible" and the other "injuries and irreversible." But in deciding on the injuries he really relied on a combination of several changes. In 1947, Sievert reviewed the findings that were reported by Helde and by Nordenson. From his knowledge of the physical conditions, he decided that as little as 0.02 to 0.05 r per day could, after a comparatively short time, give rise to changes in the blood. The changes he mentions are widely varied: a tendency to low hemoglobin among female workers; a propensity to polycythemia in both sexes; a tendency to leukopenia or leukocytosis; a shift to the left as judged by the number of rod forms; eosinophilia and/or basophilia; hypersegmentation of the polymorphonuclears; and pathological lymphocytes. From the above results, it is obvious that there is no constant pattern of response—merely a change from control groups.

Few authors have had much to say about the platelets, but Mossberg (68) believed that they are much more resistant to different external factors than the white blood cells and that they are a more sensitive indicator of effects due to radiations. Studying the blood of 24 persons on the radiological staff of one hospital, he found that 7 had a definite decrease in platelet count, 9 an uncertain decrease, and only 8 had normal counts.

During 1951, Mayneord (64), in discussing radiation protection, reviewed the findings at the Royal Cancer Hospital, where they have now for several years kept records of exposures and of blood counts. It was found that the mean total white blood cell count of the group of people who received more than 125 mr per week was definitely below that of those receiving 100 mr per week. These in turn showed a slight decrease as compared with the control group. Mayneord's conclusion is that the present concept of tolerance is either too high or that we must assume that the changes which are seen are temporary and of no real significance. It is important to note that there is considerable overlapping of the individ-

ual counts, some of those receiving 125 mr per week having as high counts as the controls and some of the controls having as low total counts as those most exposed. Blood counts are of value, therefore, in demonstrating that the working conditions are such as to cause a decrease in the mean white blood count of the group, but they are of little value in showing that any one person is affected. I hope that the persons with altered white counts will be followed for many years in order to help establish the importance of the changes. Paterson (76), in discussing this problem, stated, "At this point I come to a question that has exercised my mind greatly from time to time. These white cell changes are definite, but are they in themselves harmful? They can exist without any very tangible evidence of ill health, except perhaps slight fatigue. I believe they are in themselves bad."

In 1942 I, as the Director of the Health Division of the Metallurgical Laboratory in Chicago, was faced with the problem of whether or not to require blood counts on all of the workers who were potentially exposed to radiations. My medical colleagues and I decided to make such counts mandatory and, as a result, thousands of records of blood counts are now available; but the chances of finding anything of significance from them seems so remote that no one wants to spend much time analyzing them.

The hematological program at the Metallurgical Laboratory in Chicago was directly under Jacobson, who, with his assistants, has reported on some phases of it (46). With few exceptions, they were unable to detect in the personnel any changes in the hematologic constituents of the peripheral blood that could be attributed to radiation. Jacobson (47) concludes: "The great variation in the steady state of the various hematological constituents of the peripheral blood from one individual to another, the inaccuracy of modern methods for measuring these constituents, and the individual physiological variation from hour to hour, day to day, and month to month make it almost impossible to interpret minor fluctuations possibly due to acute or chronic radiation exposure." "Elsewhere in these volumes a statistical study of the variation in the hematological constituents of the peripheral blood in control and work-hazard groups of various ages will be dealt with. No significant alterations were found in these studies which were attributable to radiation exposure." Pearlman and Sacher (77), analyzing the data collected at the laboratory during the first year, where the known exposure was less than 0.1 r per day for almost all individuals, found that there was a slight lymphocytosis in the group of people working in the radiation-hazard areas, and also in those in the metal shops. There was a slight increase in the absolute lymphocyte count of controls as well. Hence, the increase of lymphocytes in the personnel possibly exposed to radiations was of doubtful statistical significance.

Moshman (67) has done some pilot sampling of the voluminous records from Oak Ridge, Los Alamos, and Hanford. He has shown that variations in counts of the various blood elements from site to site are quite appreciable. From his report, it would seem that the altitude of Los Alamos had a greater effect on the quantity of hemoglobin and the number of the red blood cells than did any of the near-tolerance exposures. It is also clear that, due to unknown factors, the mean total white blood count was considerably higher at Hanford than at Oak Ridge or Los Alamos. It is apparent that one can place value on trends at any one place and must use, as controls, people at the same place and at the same time. On this basis, Moshman showed a possibly significant decrease in the percentage of polymorphonuclears according to exposure among the personnel at Los Alamos, but no such decrease at Oak Ridge. Sterner (90) writes, "We have encountered many unexplained 'trends' in certain characteristics, which appeared significant—only to reverse themselves in a similarly inexplicable manner."

In considering the effects of very low levels of irradiation on the blood, some attention must be given to the recent report by Knowlton (50). He had the opportunity of following a group of 10 persons who were exposed to a total of around 0.2 r of gamma rays per week for 117 weeks, another group of 46 people who were exposed to between 0.01 and 0.1 r per week, and a control group of 117 individuals with presumably no exposure but living in the same place. The 10 people getting between 100 to 200 mr per week showed a drop of 9 per cent in the total white count, 7 per cent in the absolute neutrophils, and 15 per cent in the absolute lymphocytes. The group of 46 people receiving between 10 and 100 mr per week had approximately a 3 per cent decrease in all elements; whereas the control group had less than 0.1 per cent change in any of the elements. Whether these changes are entirely due to radiation or something else in the work or environment is not clearly established. However, the finding of such changes by one individual in one place makes it necessary that similar tests be run in other places.

Mention should also be made of the findings of bilobed nuclei in the lymphocytes of cyclotron personnel (42). Whether this is the same type of abnormal lymphocyte as was reported by Nordenson I do not know. I do know that it was not a conspicuous element in the blood of patients exposed to 5 r, 10 r, 15 r, or 20 r per day up to a total of 300 r (61, 62), even when such cells were especially sought. They were observed, but the number was not related to the amount of exposure.

Nordenson, in his studies, laid emphasis on what he called "hypersegmented neutrophils." We have hunted for these among persons receiving total body irradiation and find that at all times after treatment there was a decrease in the number of lobes per cell rather than an increase. It is possible that both of these effects are due to small chronic doses rather than to the larger doses given to patients in from fifteen to sixty days.

There are a few reports of hematologic studies on patients who were treated by irradiation of the whole body at a time when their blood was relatively normal. These give us some idea of the effects of known single and multiple exposures. Nickson (72) reports the following results: 3 people received 7 r per day for three days and 1 received 27 r in one day, with no effect; 4 people received 60 r in one dose, 3 showing a moderate decrease of lymphocytes and polymorphonuclears and 1 showing no change; and 3 got 120 r in one dose, all 3 showing a slight to moderate decrease in lymphocyte count. Low-Beer and Stone (62) and Low-Beer and Aggeler (61) followed the blood counts of 32 patients who received total body irradiation for arthritis or cancer, in doses of 5, 10, 15, or 20 r per day to total doses of 300 r. All showed initial disturbances of the blood counts, consisting of fluctuations during the fifteen- to sixty-day period of treatment and decreases almost immediately after treatment stopped. They recovered very soon. Three of these patients have been followed for three to four years, and 6 for five to eight years; the blood counts of all have returned to pretreatment or normal levels. It seems therefore that, so far as we can conclude from these experiments, it takes a greater exposure than 27 r at one time to produce effects, and the marked effects of a total exposure of 300 r in fifteen to sixty days are not permanent.

In order to learn what happens to the blood as a result of chronic daily exposures to accurately known amounts of radiation, we must turn to experimental animals. As reported by Ingram and Mason (43), the Rochester group found that the average lymphocyte count in the peripheral blood of dogs receiving 0.5 r or above was lower than that of the control animals. However, they reached the following conclusion: "In dogs and rabbits, changes in the hemograms which followed chronic exposure to whole body roentgen radiation in amounts near the tolerance range were detected only by statistical methods. In view of

TABLE V: EFFECTS OF SMALL DAILY DOSES ON PERIPHERAL BLOOD

r/Day	Effect	Animal	Observer
0.11	Reduced lymphocyte count	Guinea-pigs	Lorenz
0.11	Slight reduction of lymphocytes	Rabbits	Lorenz
0.11	Temporary reduction of platelets	Guinea-pigs	Lorenz
1.1	Reduced heterophils	Rabbits	Lorenz
2.2	Reduced platelets	Guinea-pigs	Lorenz
2.2	Reduced lymphocytes	LAF_1 mice	Lorenz
2.2	Reduced heterophils and red cells	Guinea-pigs	Lorenz
2.2	Terminal anemia or pancytopenia	Guinea-pigs	Lorenz
0.5	Reduced lymphocytes	Dogs	Ingram
0.02–0.05	Various effects on blood	Man	Sievert
0.04	Reduction of neutrophils and lymphocytes (0.2 r weekly)	Man	Knowlton

this finding, it would seem unlikely that routine hematological examination would provide a reliable means of detecting minimal radiation damage in any one animal." Among many interesting observations that they made, two others should be mentioned. In the rabbits that were given 10 r per day, the lymphocyte count fell shortly after the beginning of the exposures and then stabilized at a lower level for the duration of the experiment. It would appear as if the blood had reached a balance between destruction and regeneration very shortly after the experiment started. Some other hematologic changes were first noticed during the second year of daily exposures. These must, therefore, be due to a cumulative effect.

The only chronic exposures that have been carried out at and near the "tolerable" amount of ionizing radiations for the full lifetime of the animals are those that have been given by Lorenz and associates (58, 59). The smallest doses that were found by these workers to produce given effects are shown in Table V. The effects were studied by using the mean count for experimental and control groups of animals. The absolute lymphocyte count of guinea-pigs was reduced with 0.11 r per day (eight hours). All dose levels above 0.11 r per day produced more marked effects. The rabbits exposed to 0.11 r per day (eight hours) showed a slight reduction of the lymphocyte count, but there was not much greater change with larger doses. Hence, the significance of this finding is somewhat doubtful.

At the 1.1 r per day (eight hour) level, Lorenz found a slight reduction in the platelets of the guinea-pigs between the forty-ninth and seventy-ninth weeks, but this was followed by recovery to normal levels. At this same level the rabbits' heterophils became reduced, but only to a small extent. The first definite reduction of the absolute lymphocyte count of LAF_1 mice was at the 2.2 r level of exposure. At the 2.2 r level of exposure there was an early reduction of the heterophils and the red blood cells in the guinea-pigs, and later terminal anemia or pancytopenia developed in these animals.

The data just quoted relative to mice were gleaned from the manuscript for a book shortly to be published (59). More recently, further experiments were completed with LAF_1 mice, and the findings in the peripheral blood, as analyzed by Lorenz and Jacobson (60), are somewhat different: "....the total leukocyte and lymphocyte counts are significantly depressed only in the 8.8 r groups of both males and females, and ... this depression is established early and maintained throughout the experiment. The lymphocytes are depressed in the males receiving 4.4 r daily, below those in the controls. It is not clear whether this depression is significant. The heterophil-leukocyte and platelet counts are probably not significantly lowered in any group of either males or females. The red cell counts and hemoglobin values are reduced only in the animals exposed to 8.8 r daily for about a year." This report is somewhat at variance with the other and casts some doubt on the significance of the changes reported as occurring at the low levels of dosage.

We must remember, however, that variations in animals occur not only between species, but also between strains and families of the same species. Jacobson, Marks, and Lorenz (47) have listed animals in terms of the increasing sensitivity of their blood and blood-forming tissues to one-dose whole-body exposure as follows: rabbits, rats, mice, chicks, human beings, goats, guinea-pigs, and dogs.

At the bottom of Table V, I have added the low levels of 0.5 r per day for dogs as found by Ingram and 0.02 to 0.05 r per day for man as found by Sievert and Knowlton. It cannot be doubted that very small daily doses have caused changes in the blood of guinea-pigs, mice, rabbits, dogs, and men. Whether the slight changes are significant or serious is a matter for individual opinion now just as it was to Aubertin (2) and Béclère (6) in 1912, but on these figures your concept of a maximum permissible exposure for the blood must be based.

PRODUCTION OF LEUKEMIA

The next effect of radiation that we must consider is the production of leukemia. Several authors have attempted to show that leukemia is more prevalent in radiologists than in other physicians. In his latest report, March (63) showed that leukemia is nine times as frequent among radiologists as among other physicians. Henshaw and Hawkins (38) have shown that the incidence of leukemia in all physicians is almost twice as great as that in the population as a whole. This may be because many physicians who are not classed as radiologists use x-rays and radium. While the implication that long-continued total-body irradiation is a factor in the induction of leukemia is probably correct, we should bear in mind that March's basic figures are 14 deaths from leukemia among a total of 299 deaths of radiologists.

From the experiments with animals, it appears that leukemia is induced by chronic irradiation mainly in animals in which the disease develops spontaneously, such as mice. Leukemia was induced seldom if at all in dogs, rabbits, or guinea-pigs. In the LAF_1 mice used by Lorenz (56, 58), the age of appearance and percentage of animals showing leukemia were altered by doses of 4.4 r and 8.8 r per day (eight hours) but were not altered by lower doses. At Rochester, Barnett (4) and Metcalf and Inda (65) found no leukemia in control rats, but some leukemia developed in rats exposed at all levels, the incidence increasing with increase in the daily dose from 0.1 to 10 r.

Since leukemia does appear spontaneously in man, we may be justified in assuming that ionizing radiations could increase its incidence and lower the age of appearance. Lorenz (56) doubts this, as is evident in the following quotation: "Comparing the irradiation conditions that induce lymphoid tumors in animals to those that the radiologist is exposed to, the following facts are found: Chronic irradiation produces this disease in mice only when young animals are exposed chronically to a dosage rate to the whole body far exceeding that which the radiologist encounters in radiological work. In addition, roentgenoscopy involves only part of the body. Such exposure in mice has only a negligible effect on leukemia incidence. Furthermore, the radiologist is exposed mainly to soft radiations so that the average tissue dose is very small in comparison to the skin dose; whereas, in mice the tissue dose is uniform and approximately equal to the air dose. Finally, in guinea-pigs in which the spontaneous incidence of leukemia is small, no evidence has been found to indicate that long-continued irradiation will increase the spontaneous incidence."

In forming a concept of the maximum permissible exposure, we certainly want to exclude the possibility of the production of leukemia even in the most sensitive workers. There have been no human beings with leukemia whose exposure is known. One would expect the mouse to be the animal most likely to show this effect with low doses, but apparently

TABLE VI: EFFECTS OF SMALL DAILY DOSES: INDUCTION OF MALIGNANT TUMORS

r/Day	Effect	Animal	Observer
0.11	Ovarian tumors, lung tumors	Mice	Lorenz
0.11	Mammary sarcoma	Mice	Lorenz
1.1	Mammary carcinoma	Mice	Lorenz
4.4	Leukemia (lymphomatous tumors)	Mice	Lorenz
1.1	Increased numbers of lung tumors	Guinea-pigs	Lorenz
Up to 8.8	No induced leukemia No ovarian tumors	Guinea-pigs	Lorenz
1.1	Cancer of uterus with metastases	Rabbits	Lorenz
Up to 8.8	No ovarian tumors No induced leukemia	Rabbits	Lorenz
0.1?–1.0	Leukemia and lymphomablastoma	Rats	Barnett

4.4 r per day is near the threshold dose. The disturbing fact is that rats show an increase with 0.1 r per day (short exposure). More experiments should be done on rats, since the number with leukemia from any exposure was small.

I have not reviewed the subject of the production of anemia. Aplastic anemia has occurred in some radiologists (13). They apparently received relatively large doses, but we can only guess at the amounts. In guinea-pigs anemia developed with exposures as low as 2.2 r per day (eight hours) (56, 58). It would seem that other effects than the production of anemia will be the limiting factor in establishing a maximum permissible exposure. It is also possible that the production of anemia is of more significance than the changes in the white blood cells that occur with the very low doses.

INDUCTION OF MALIGNANT TUMORS

In Table VI are shown the lowest doses that caused malignant changes. Lorenz (56, 59) found that ovarian tumors, lung tumors, and mammary sarcomata were more frequent, more numerous, or appeared earlier in mice exposed to 0.11 r and above per day than in control animals. The ovarian tumors, however, are peculiar to mice and the mammary sarcomata are probably correlated with the growths on the ovary. The lung tumors were greater in number per animal, but the number of animals in which such tumors developed was not increased by 0.11 r per day.

In guinea-pigs some lung tumors develop spontaneously. The incidence of these tumors was not increased, but "multiple" tumors were seen more frequently. In rabbits the incidence of a uterine cancer was found to be significantly higher in irradiated animals receiving 1.1 r per day (eight hours) or more than in controls. In the controls the tumor usually remained localized, while in the irradiated animals it metastasized to many organs.

Barnett (4), reporting for the Rochester project, found a significant increase in the incidence of tumors in rats getting 1.0 r per day and above.

It is apparent from these findings that even as little as 0.11 r per day (eight hours) causes some changes in these animals that are deleterious and irreversible and, therefore, must be taken into account in forming a concept of a maximum permissible dose.

OTHER DELETERIOUS EFFECTS

Cataract Formation: The first of the "other deleterious effects" mentioned by the International Commission is cataract formation. This seems to be a special problem related to neutron irradiation. The mice, guinea-pigs, and rabbits receiving 8.8 r per day at Bethesda, starting at time of maturity, showed no opacity of the cornea nor cataract formation, nor did the rats and dogs getting up to 10 r per day on the Rochester program. The total accumulated dose in rabbits on the chronic exposures was 12,000 r. Lorenz and Dunn (57), however, were able to cause eye lesions in strain A mice with acute doses of radiation applied at the time of birth, even though the dose was only 400 r. At the Clinton Laboratories (79, 95), corneal opacities were produced in animals treated with beta

rays at the level of 50 rep per day. Failla and Evans at Columbia produced numerous cataracts with low-dosage irradiation with neutrons. It would thus appear that within the range of permissible dose to the skin for x-rays and gamma rays, and probably for beta rays, there is likely to be no change in the cornea or lens. This, however, is not true for neutrons, as has been amply brought out in the recent literature concerning the cyclotron workers in whom cataracts developed.

Obesity: The International Commission chose to class "obesity" as one of the deleterious effects. I do not know of it as a radiological problem in man, but Lorenz (59) observed that among the hardy LAF_1 mice, particularly the males, the weights of all animals getting from 0.11 r to 4.4 r per day (eight hours) were above the weights of their controls. Late in life the mean weight of these experimental animals came down to equal that of the controls. This weight increase was due chiefly to an increase in abdominal fat. Lorenz offers no explanation for this phenomenon, but points out that it is not due to sterilization, since it occurred most often in males who were not sterile.

Reduction of Life Span: An interesting observation that has been made by those experimenting with chronic irradiation of mammals at the near-"tolerance" level is that there is a decrease in the average life span of a given group of exposed animals, with no specific cause of death being determined. Lorenz (56) has shown that 2.2 r per day (eight hours) was sufficient exposure to cause a definite reduction of the life span of LAF_1 mice and of hybrid guinea-pigs. Henshaw *et al.* (39), using CF_1 mice, thought the threshold dose for shortening the life span was about 1 r per day (short exposure period) for gamma rays from tantalum. On the basis of the data for rat survival at Rochester, Boche (9) felt that he could detect a possibly significant reduction of the life span of rats exposed to 0.1 r per day and a definitely significant reduction with exposure to 0.5 r per day. If longer lived animals were used, it might be possible to detect effects on the life span from lower daily doses.

Impaired Fertility: Little is known about the fertility of radiologists and other workers subjected to daily radiations. Our complex social structure would make it very difficult to attribute small families to radiation effects. As a matter of fact, we know from acute exposures for therapeutic purposes that it takes more than 625 r delivered to both ovaries in a few days to produce permanent amenorrhea in women, although temporary amenorrhea may follow lower doses. To produce complete aspermia in men, a considerably higher dose is required. On the basis of these considerations, it probably would take quite a large daily dose to produce sterility in either men or women.

As a result of animal experimentation, we find that there are great differences in the sensitivity of the ovaries and testes of different species. Rabbits are much more resistant than dogs, mice, or guinea-pigs. In an interesting experiment, Deringer, Heston, and Lorenz (58, 59) had animals live continuously (twenty-four hours a day) and breed in the field of irradiation of gamma rays from radium. Mice of the dba and C_3H strains so exposed to 1.1 r per day (twenty-four hours) lived for five and six generations respectively. The average litter size produced by the successive generations was normal as compared with the average litter size of controls. Under the same conditions, however, the offspring of females exposed to 4.4 r daily (twenty-four hours) failed to produce any young except in one instance.

In another series of experiments, the testicles and ovaries from mice that were exposed for eight hours per day to various levels were examined pathologically. The lowest exposure to show an effect was 1.1 r per day. This effect was a decrease in the number of spermatogonia in mitosis, and after eighteen months of such exposure there was a decrease in the follicles present in the ovary. Eschenbrenner (22) found that the weight of the testicles was a

TABLE VII: EFFECTS OF SMALL DAILY DOSES ON GONADS

Daily Dose	Effect	Animal	Observer
1.1 r (24 hr.)	No effect on breeding	Mice dba	Lorenz, Heston, *et al.*
4.4 r (24 hr.)	Sterility developed	Mice dba	Lorenz, Heston, *et al.*
1.1 r (8 hr.)	Decrease in spermatogonia in mitosis	Mice	Eschenbrenner *et al.*
1.1 r (8 hr.)	Decrease in follicles in ovary after eighteen months	Mice	Lorenz *et al.*
0.1 r	Sperm reduction (questionable)	Dogs	Boche
0.5 r	Sperm reduction	Dogs	Boche
1.0 r	50 per cent aspermic after nine months	Dogs	Boche
0.5?–1.0 r	Testicular atrophy	Dogs	Barnett (Rochester)
1.1 r	Decreased testicular weight	Mice and guinea-pigs	Lorenz and Eschenbrenner

sensitive measure of the effect and that even males which were fertile might have a decreased testicular weight due to a decrease in the number of spermatogenic cells. He was able to demonstrate such a decreased weight in mice and guinea-pigs after exposure for some time to 1.1 r per day.

In a study of the dogs on the Rochester project, Boche (9) found that after 0.1 r per day there was a questionable reduction in the sperm count, and that after 0.5 r per day there was a very definite reduction. Nine months after the beginning of exposure of dogs to 1 r per day, 50 per cent of them were completely aspermic. Barnett (4), reporting on the pathological changes in the dogs exposed to chronic irradiation at Rochester, says that he found testicular atrophy questionable at the 0.5 r per day level and definite at the 1 r per day level.

From the foregoing observations we must therefore conclude that, in so far as effects on the ovaries are concerned, they have been demonstrated in mice at a 1.1 r per day level; and in so far as effects on the testicles are concerned, they are certainly demonstrated at 0.5 r per day in dogs and are very positive at 1 r per day in both dogs and mice. It is possible that a real effect could be demonstrated at the 0.1 r per day level in dogs if exposure was continued for a long time.

GENETIC EFFECTS

The language of the geneticists is to me very difficult. I find it almost impossible to translate or to get them to translate their findings from animal experiments into terms that clarify my thinking relative to problems of human genetics. There are a few points, however, that I think I understand, and they seem important to me. Mutations are occurring continuously in all plants and animals. The rate at which these occur is called the "spontaneous" mutation rate. Exposure to ionizing radiations, chemicals, etc., causes an increase in this rate, but no new types of mutations occur.

If there is one single most important fact to remember, it is that the effects of radiations on genes are totally cumulative throughout the reproductive period and are not dependent on the dose rate. All of the radiation received during the reproductive period must be taken into consideration in calculating the possible number of gene changes that will be passed on to the last children to be born. Let me state this in another way. In so far as changes in genes are concerned, the same result will be obtained whether the radiation is received by the gonads at the rate of 0.3 r per week for fifty weeks a year for ten years, or at the rate of 150 r per minute for one minute. For this reason, the geneticists feel that a maximum permissible total lifetime (or reproductive period) exposure should be added to the present rules.

Some genetic effects are not due to gene mutations but to changes in the chromosomal structure, called "chromosome aberrations" (37). Such changes result in an altered relation of genes to each other or in the loss of genes rather than in mutations. In the production of such

effects, the radiations are not totally cumulative, but there is a dose-rate dependence. Even though for acute exposures only a few roentgens are needed to cause such changes, Deringer, Heston, and Lorenz (20) state: "Subsequent generations [of C_3H and dba mice] reared and living while exposed to 1.1 and 0.11 r daily for twenty-four hours show no damage to chromosomes as evidenced by a raising of 5 to 6 generations with normal litter size and apparently normal life span." Later in the same book Lorenz comments: "Likewise, no evidence for the production of translocations was obtained in tests of the offspring of male LAF_1 mice that received 1,100 r at the rate of 8.8 r daily, eight hours, or of the offspring of female mice that received a total dose of 770 r at the rate of 8.8 r daily, twenty-four hours. This is in contrast to observations of hereditary changes (translocations) studied in the offspring of mice subjected to acute exposures."

In the period before 1943, most of the studies in laboratories of genetics were made on the effects of x-rays and gamma rays on the fruit fly, *Drosophila melanogaster*. In many of these studies, the stated dose was the cumulation of daily doses. However, the early stages of spermatogenesis in *Drosophila* occur in larvae and pupae, and in the adult fly the nearly mature cells predominate. Similar conditions in man exist for a maximum of twenty-one days during which mature sperm cells remain fertile in the epididymis. In the adult female fly there is a complete absence of follicular differentiation. Women, on the other hand, enter the reproductive period with 450,000 follicles, of which only about 450 subsequently mature (30). Thus in man or mammals severe damage to any of the developing sex cells would prevent them from entering mitosis or cause them to be destroyed during mitosis; hence they would never become mature ova or spermatids.

Some help in understanding how far the results from *Drosophila* experiments can be used to predict results in man has come from experiments on mice, carried on since the development of the Atomic Energy program. At Rochester, Charles (14) exposed mice to x-rays at the rate of 0.1 r, 0.5 r, 1 r, and 10 r per day. He obtained his results by breeding the exposed mice. He concluded that new mutations occur in about 1 per cent of mouse sperm for each 100-r exposure (cumulated). Russell (87), at Oak Ridge National Laboratory, giving single acute doses to mice, reports that the mutation rate per roentgen is considerably higher in the mouse than in *Drosophila*. Russell concludes: "From a cautious scientific point of view, it would be unwise to generalize from this, but from the point of view of those concerned with the immediate problems of protection in man, it would be risky to ignore the fact that the data indicate that estimates of human hazards based on *Drosophila* mutation rates may be too low."

Some radiologists think that, if the chance of a visible mutation being produced is increased by 50 r from 1 in 1,000 to 2 in 1,000, there is nothing about which to get alarmed. I might say that for the individual there is very little cause for worry, but for the future of the human race, with an ever increasing application of radiations, there is a real problem. Muller (69) said several years ago: "We must remember that the thread of germ plasm which now exists must suffice to furnish the seeds of the human race even for the most remote future. We are the present custodians of this all-important material, and it is up to us to guard it carefully and not contaminate it for the sake of an ephemeral benefit to our own generation."

In the light of present knowledge, it seems impossible for the "spontaneous" mutations to be due to unavoidable radiation—that due to cosmic rays and the natural radioactive elements, both solids and gases, that surround us and are in us. Table VIII lists the estimates of the "natural" radiation by various authorities. Cosmic rays vary from place to place,

TABLE VIII: UNAVOIDABLE DAILY RADIATION

Source	Dose per Day in Roentgens	Data from
Cosmic rays at sea level	0.0001	Sievert
Cosmic rays and local gamma	0.0003	Evans
Naturally occurring radio-elements	0.001	Sievert
Cosmic rays and ground radiation	0.002	Lea
Radio-elements in the body	0.0001	Brues
Carbon^{14} 3×10^{-6}		
Potassium^{40} 1×10^{-4}		
Radium 4×10^{-6}		
Probable maximum	0.0021 = 2.1 mr/day	

especially with altitude. The amount of uranium and thorium and their decay products in the ground also varies from place to place. The amount of the gases, radon and thoron, will vary at any one location with weather conditions. It is obvious, however, that even the maximum of 2.1 mr per twenty-four hours is too little to account for the spontaneous mutations.

How are we to form a concept of a maximum permissible exposure in such a complex situation as this? Since any amount is deleterious, it is a question of how much damage we are willing to accept as "permissible." Moreover, the geneticists cannot yet give us accurate figures. On the credit side are the facts (*a*) that most people will just begin to work where potential exposure is present at the start of childbearing, and (*b*) that few people are ever subjected to the maximum permissible exposure. On the debit side is the fact that, taking the broad view, it is the total exposure of a whole population that counts. Thus our concept must include the total amount per person during the childbearing period, and the proportion of the population that is involved. If we are willing to accept a doubling of the "spontaneous" mutation rate in the whole population, and if 45 r doubles it in the individual, then at the rate of 0.3 r per week for fifty weeks per year, that individual could work for three years. If, however, only 10 per cent of the population is exposed, then the individuals exposed could get ten times as much exposure before the whole population was equally affected, *i.e.*, thirty years. Since most of those working with radiations actually receive about 0.03 r per week, 1.5 r per year, and 45 r in thirty years, it would be permissible for 20 per cent of the population to work in such areas of potential exposure. I have omitted all reference to exposures for diagnostic purposes. A warning is needed, however, lest exposures for diagnosis or for surveys cause more genetic change than a lifetime of work with ionizing radiations.

DISCUSSION

Now that we have reviewed some of the effects produced in animals and man by chronic continuous or repeated exposure to ionizing radiations at low daily rates, we must try to form a concept of a maximum permissible exposure. Mutscheller (71), in 1925, said it must be a dose which an operator can tolerate for a prolonged period of time without suffering injury. Failla (24) defined it, in 1932, as that dose which would produce no permanent physiological changes in the average individual. In 1933, Taylor (91) defined it as the amount of roentgen-ray energy that a person may receive continuously or at repeated intervals without suffering any damage to the blood or reproductive organs. Binks (7), in 1943, said that it is the amount of radiation which the body will tolerate without ill effects. Sievert (88), in 1947, wrote that it should be from one- to two-tenths of the minimum dose which causes a scarcely perceptible biological effect of a certain type. Cantril (12) defined tolerance dose as that dose to which the body can be subjected without the production of harmful effects.

It is apparent that all of them were thinking of demonstrable changes in the exposed individuals. With improved methods of investigation, it is now possible to demonstrate some changes from doses much below the former tolerance dose. We must decide what alterations are significant. With our present knowledge of genetics, we must consider not only the

individual exposed but his offspring and the whole future population of the world. On the basis of present knowledge, any amount of radiation, no matter how small, causes some biological effect.

Looking at the practical side, those who have been obviously injured by chronic exposure to ionizing radiations have had changes in the skin and blood; and those who have died as a result of injuries have had skin cancer, leukemia, or aplastic anemia. The possibility of infertility and of defective offspring has been the greatest source of worry. Hence, the skin, blood, and gonads become the limiting tissues. Because of reports of animal experiments, the deleterious effect on life-span is also a possible limiting factor.

Our data relative to the exact doses that cause minimal changes in the skin of the hands is very limited: Parker, by observation and measurement, 4 r per week or 0.8 r per day; and Sievert, by extrapolation, 0.1 to 0.5 r per day (over a thirty-year period). The animal exposures are of little help, since (*a*) skin changes are slow in developing and animals do not live long, and (*b*) the skin of the animals used requires a much larger single acute dose of radiation to produce an erythema than that of man. It is to be hoped that, out of the many measurements now being made directly on the hands of atomic physicists, radiochemists, and radium workers, more definite data will become available. At the present time, the International Commission recommends 1.5 r per week. This amount does not include much margin of safety.

The evaluation of changes in the peripheral blood presents one of the greatest problems. Sievert, in Sweden, and Knowlton, in the United States, have demonstrated changes associated with exposures of 0.2 r per week. Mayneord, in England, showed changes in personnel exposed to 0.1 r per week. If the changes they show are significant, then the present maximum permissible exposure of 0.3 r per week is too high. I hope the individuals showing these effects will be followed for many years. In contrast to these, Jacobson found little change in the workers on the Metallurgical Project, and Moshman's findings are not uniform. Throughout the war years, hundreds of thousands of blood counts were done on "potentially exposed" personnel and many of these wore monitoring instruments as well. No real correlation was found between blood counts and exposures. Thousands of blood counts are still being done daily on personnel who are also monitored. This is a terrific waste of money, time, manpower, and effort. Jacobson says: "Interpretation of individual counts and direct correlation with exposure is quite difficult and probably impossible." In my opinion a few small groups of people with well controlled exposures and frequent blood counts should be followed for several years *as an experiment*, but mass counting should be discontinued.

Blood counts on a routine basis have not helped to detect the onset of leukemia. So far as is known, leukemia does not follow any other blood abnormality. In animals, it takes larger doses of radiation to induce lymphoid tumors than it does to alter the white blood count. Hence, if our maximum permissible exposure is below that which causes definite non-leukemic changes, it should be low enough in so far as the induction of leukemia is concerned.

There is no threshold for genetic mutations and, therefore, any maximum permissible dose is arbitrary. Sterility is no problem with most animals when exposed to 1 r per day or less. The dog is the exception. Boche believed there was a significant reduction of sperm in dogs exposed to 0.5 r per day, and Barnett found suggestive changes in the testes of such dogs. Assuming that man responds similarly, 0.05 r per day should be a safe dose for the gonads.

It is now possible to have a more accurate concept of a maximum permissible exposure than it was in 1942. More is known about the hazards of radiations than of many drugs and chemicals. There is less reason to be afraid of ionizing radia-

tions than of many other hazards in life. If exposures are kept as low as possible and not above the maximum permissible, there should be no significant effect on skin, blood, or gonads, and a very minor increase in mutated genes.

The International Commission on Radiological Protection expressed the present situation quite well in its 1950 report (44): "While the values proposed for maximum permissible exposures are such as to involve a risk that is small compared to the other hazards of life, nevertheless in view of the unsatisfactory nature of much of the evidence on which our judgments must be based, coupled with the knowledge that certain radiation effects are irreversible and cumulative, it is strongly recommended that every effort be made to reduce exposures to all types of ionizing radiations to the lowest possible level."

SUMMARY

1. Radiation injuries have been observed since one month after the discovery of x-rays was announced.

2. Protective measures were purely empirical at first.

3. The idea of a "tolerance" dose evolved slowly, delayed by the lack of a method of accurately measuring ionizing radiations.

4. A great deal is known now about how radiations act on living material. Some changes are produced by very small doses.

5. Irreversible and cumulative changes occur.

6. Skin changes may appear as long as twenty-five years after exposure ceases. As little as 0.8 r per day *may* cause skin changes.

7. Some changes in the blood may result from weekly exposures of 0.1 r, but the significance of these changes is not known.

8. Leukemia and lymphoid tumors are produced in rats and mice and probably in human beings by ionizing radiations, but the dose required is greater than that which causes some other changes.

9. Many malignant tumors can be induced in animals exposed to radiations, but the doses required exceed those necessary to produce blood changes.

10. Life-span reduction and impaired fertility are not problems at dose levels below those set by skin and blood effects.

11. Gene mutations are caused by ionizing radiations, and the effect is proportional to the total dose. Mice genes probably are more sensitive than those of the fruit fly.

12. The concept of a maximum permissible exposure now rests on a fairly large number of experiments and observations.

13. There is no need to fear ionizing rays since the hazard is known and means of protection are available.

14. The International Commission on Radiological Protection (44) recommends 0.3 r per week measured in free air (0.5 r on the body surface) as the maximum permissible exposure to the whole body or gonads. In the case of the hands and forearms, they recommend 1.5 r per week. Both of these refer to externally originating x- or gamma rays of quantum energy less than 3 mev.

15. Complete recommendations from the National Committee on Radiation Protection (U. S. A.) will appear soon.

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SUMARIO

El Concepto de la Exposición Tolerable Máxima

La máxima dosis tolerable de irradiación, antiguamente llamada "dosis de tolerancia," ha sido definida como la mayor exposición en cualquier período de tiempo escogido, ya sea un día o una semana, a la que uno está dispuesto a someter repetidamente ya su propio cuerpo o el de cualquier otro. El concepto de dicha dosis tiene que basarse en los resultados de las exposiciones crónicas del hombre y de los animales de ensayo que han descrito varios técnicos.

En los años transcurridos desde el descubrimiento de los rayos X, mucho es lo aprendido acerca de la forma en que las radiaciones obran sobre las materias vivas, y el concepto de la máxima exposición tolerable se asienta hoy día en un número

bastante crecido de experimentos y observaciones que se repasan aquí a fondo. Es sabido que dosis pequeñísimas provocan algunas alteraciones y también que sobrevienen alteraciones irreversibles y acumulativas.

Los sujetos manifiestamente lesionados por la exposición crónica a rayos yonizantes han experimentado alteraciones en la piel y la sangre, en tanto que los fallecidos a consecuencia de lesiones irradiatorias han tenido cáncer cutáneo, leucemia o anemia aplásica. La posibilidad de que haya infecundidad o prole defectuosa es lo que ha ocasionado más preocupaciones. La piel, la sangre y los gonados son, pues, los factores que limitan la exposición tolerable.

Pueden presentarse alteraciones cutáneas hasta a los veinticinco años de cesar la exposición. Hasta 0.8 r al día pueden motivar lesiones cutáneas.

Pueden sobrevenir algunas alteraciones sanguíneas con exposiciones semanales a 0.1 r, pero no se conoce la significación de esas modificaciones. En las ratas y los ratones, y probablemente en el hombre, las radiaciones yonizantes producen leucemia y tumores linfoideos, pero la dosis requerida para ello es superior a la que ocasiona otras alteraciones.

En los animales expuestos a la irradiación, muchos han sido los tumores evocados, pero aquí de nuevo, las dosis requeridas exceden las necesarias para producir lesiones en la sangre.

La disminución de la duración de la vida y el deterioro de la fecundidad no constituyen problemas a dosis inferiores a las que provocan efectos en la piel y la sangre. No hay línea divisoria para las mutaciones genéticas, y por lo tanto, toda dosis tolerable es arbitraria.

Al concluir, declárase que, ya reconocido el riesgo y contándose con medios de protección, no hay para que temer los rayos yonizantes. Si se mantienen lo más bajo posible las exposiciones y no se excede del máximo tolerable, no debe haber efecto significativo en la piel, sangre o gonados, y el aumento en los genos mutados será muy pequeño.

Experiences with Benign Bone Tumors in Pediatric Practice[1]

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WE HAVE MADE AN analytic study of 412 bone tumors in children from infancy to fourteen years of age seen at the Children's Mercy Hospital (Kansas City, Mo.) and in our private practice of radiology within a period of fifteen years. These cases have been reviewed with two primary problems in mind: first, a correlation of the roentgenologic and pathologic findings; second, a reclassification of some of the tumors, since during and immediately after this period several new entities came to light. These entities include three new lesions of bone, namely, osteoid osteoma, fibrous dysplasia, and eosinophilic granuloma. Whether these conditions represent true bone tumors will not be discussed here. Attention will be directed rather to their clinical and pathologic aspects. Instances were found in which originally both the radiologic and pathologic diagnoses were at fault. After careful roentgen examination and evaluation of the history in view of the three new entities mentioned, we were able to suggest the histology of the bone lesion in 90 per cent of the cases.

OSTEOID OSTEOMA

Osteoid osteoma was first described in 1935 by Jaffe (8). It is a small, round or oval nidus-like lesion of bone seldom exceeding a centimeter in its greatest diameter.

CASE I (Fig. 1): M. R., a 14-year-old white girl complained of pain in the back of the neck for seven months. The pain was at first intermittent but became increasingly severe until it kept her awake at night. Roentgen examination revealed a small (7 mm.) lytic lesion containing a rounded sequestrum in the dorsal spinous process of the fifth cervical vertebra. Though there is little osteosclerosis around it, we believe it is an osteoid osteoma (Fig. 1C).

CASE II (Fig. 2): W. C., a 14-year-old boy, was admitted to the hospital complaining of pain in the neck of six months duration, aggravated by all movements but particularly by flexion. Laboratory examinations of the blood were negative. X-ray examination revealed an osteolytic lesion of the fifth cervical vertebra confined to the pedicle and to the body of the vertebra. No sclerosis was present except posteriorly. The lesion was biopsied and curetted. The pathologist made a diagnosis of osteogenic sarcoma and suggested radiation therapy, which we declined to give. Further analysis of the lesion proved it to be an osteoid osteoma. The diagnosis of malignant growth is common in this entity.

Follow-up in this instance showed alleviation of symptoms and no roentgenologic evidences of recurrence.

CASE III (Figs. 3–5): J. H. H., aged 9 years, first experienced pain in the lower leg seven months prior to admission to the hospital. At the time of examination he had been limping for a week. No redness or elevation of temperature was found. There was minimal swelling. X-ray examination revealed a small lytic lesion, subperiosteal in type, surrounded by a large zone of sclerotic bone (Fig. 3), which we believed to be an osteoid osteoma. Block dissection of the affected bone was done. The pathological diagnosis was osteoid osteoma.

The child did not do well following operation. The pain grew worse and roentgenograms demonstrated progression of the lesion (Fig. 3B). A second biopsy showed osteogenic sarcoma of the periosteal type. The parents would not permit surgical amputation for over a year (Fig. 4). It was then done, but the child died of pulmonary metastasis.

Osteoid osteoma can lie within any portion of the affected bone. Though the nidus-like focus may be small, the total abnormal zone of reaction may be very large, with thickening and sclerosis extending for several centimeters around the nidus. The lower limbs are affected more often than the upper, and the lesion may occur in the vertebral column as well as the pelvis. The femur and tibia are by far the most common sites.

Whether osteoid osteoma is truly a benign tumor of bone or whether it represents an atypical infectious lesion is still being argued. Ghormley (3) in this

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

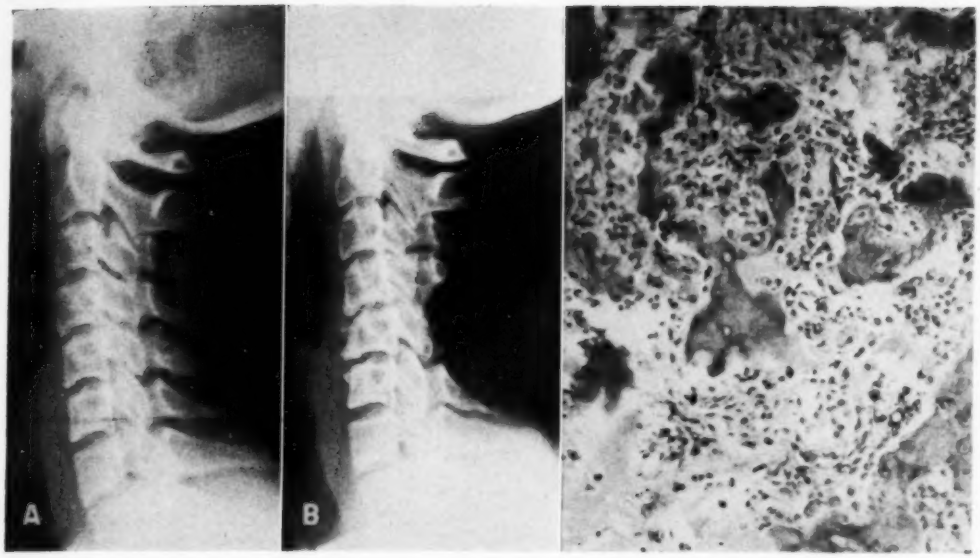

Fig. 1. Case I: Osteoid osteoma

A. Lateral view of cervical spine showing lytic lesion in the dorsal spinous process of C-5 with little surrounding sclerosis.
B. Postoperative film showing resected area.
C. Photomicrograph showing atypical osteoid tissue in a fibrous stroma.

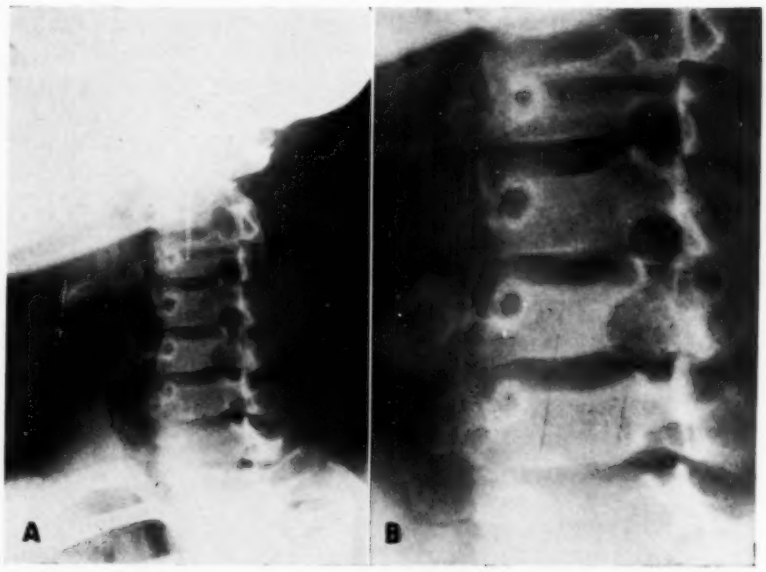

Fig. 2. Case II: Osteoid osteoma

A. Oblique view showing an osteolytic lesion involving the pedicle and body of the fifth cervical vertebra.
B. Enlargement of same.

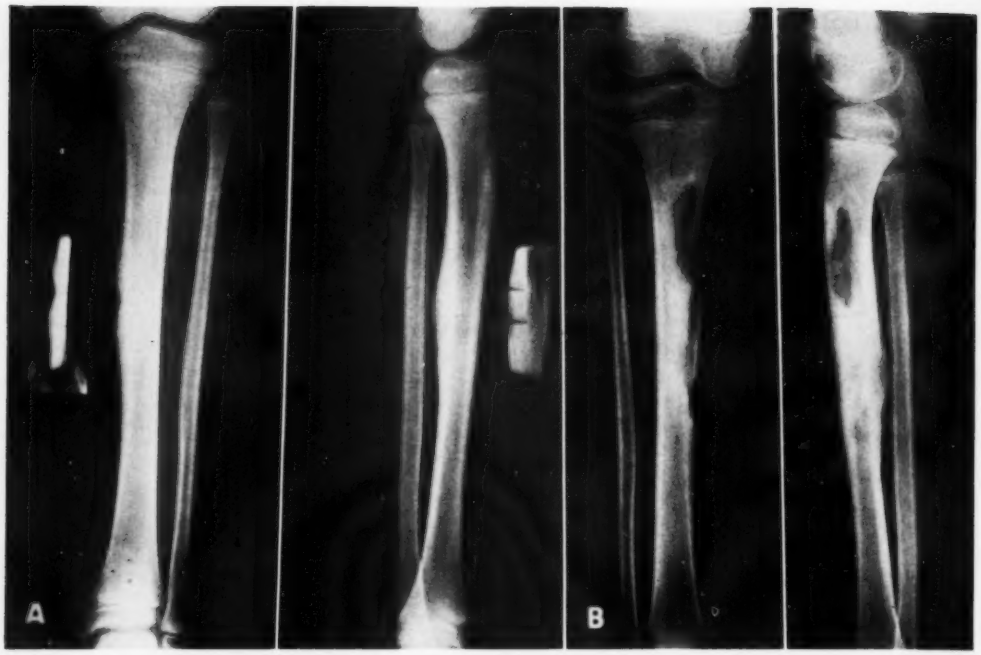

Fig. 3. Case III: Osteogenic sarcoma diagnosed as osteoid osteoma
A. Anteroposterior and lateral views of right tibia showing subperiosteal bone destruction surrounded by a marked sclerotic process. Inserts are radiographs of the resected specimen.
B. Radiograph made three months later, showing poor effort at healing. A second biopsy was done.

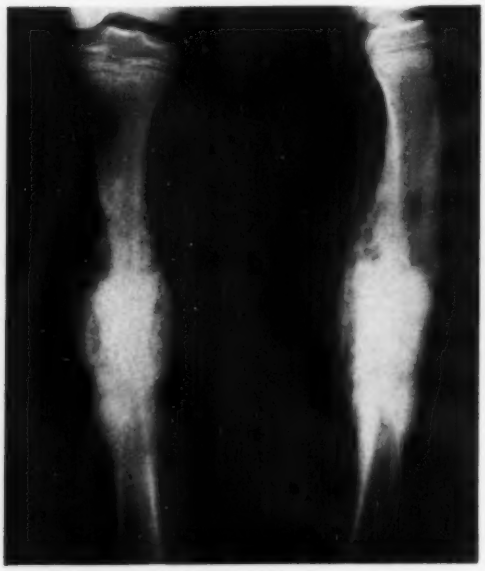

Fig. 4. Case III: Radiograph showing lesion illustrated in Fig. 3, now wildly proliferative and appearing highly malignant.

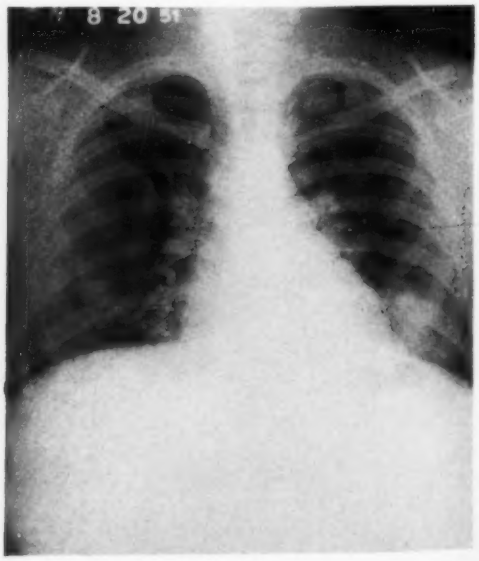

Fig. 5. Case III: Chest roentgenogram showing metastatic involvement.

country and Brailsford (2) in England feel that it is definitely of an infectious nature, a true sclerosing osteitis. The clinical and roentgenologic manifestations, however, support Jaffe's contention that we are dealing with a true neoplasm. Adherents of the infectious theory state that the lesion is nothing more than a subcortical bone abscess which has produced minimal destruction but has evoked a pronounced sclerosing response on the part of the bone surrounding it.

Clinically, the course is very benign. The history is often one of long duration, the patient having complained of pain in the affected bone for months or even years. The pain is not severe. At first it is inconstant but increases until it keeps the patient awake at night. Swelling is often absent. When the lower extremities are involved, disability and a limp may be present. Heat, fever, and erythema are unusual. A history of trauma is not common.

Jaffe's (8) microscopic description of the lesion in 1935 has remained unchanged. The histologic picture is one of dense sclerotic overgrowth of bone, and diagnosis cannot be made until the nidus is seen. This consists chiefly of fibrous tissue containing varying amounts of lymphocytic infiltration. Cultures have always been negative. Rudimentary islets of bone may be present (Fig. 1C). X-ray examination gives the most valuable information for a diagnosis. We feel that the picture is characteristic, showing an extremely dense, sclerotic radiopaque zone containing a small oval or rounded area of radiolucency. This radiolucent area may contain a tiny rounded sequestrum of bone (Fig. 1A). The extent of these zones varies; the outer one may be visible for 3 to 4 cm. The nidus may appear immediately beneath the periosteum, deeper in the cortex of the bone, or actually within the medullary canal. If one encounters the disease early in its inception, the diagnosis is often difficult, if not impossible, since the reactive elements of the bone are not then apparent on the radiograph. On the other hand, if the lesion has existed for a long period, the surrounding sclerosis may be so dense that one cannot demonstrate the nidus.

To be considered in the differential diagnosis are chronic osteomyelitis or sclerosing osteomyelitis described by Garré and atypical osteosarcoma (Case III) and endothelioma of bone. The well localized topographic pattern and absence of true bone destruction characteristic of osteoid osteoma help to distinguish it from malignant bone disease.

Treatment consists in surgical removal. Block dissection is best whenever it can be done. If, however, the lesion does not lend itself to block dissection, thorough curettage is a curative procedure. Roentgen therapy has been tried and has cured some cases. Complete and immediate relief from pain is a constant finding following surgical removal.

FIBROUS DYSPLASIA

Fibrous dysplasia of bone was discovered during the past decade and its diagnosis is commonly made today. Synonymous terms are osteodystrophia fibrosa unilateralis with pubertas praecox, polyostotic fibrous dysplasia, and osteitis fibrosis disseminata. Albright (1) and Lichtenstein (12) in this country and Goldhammer, Boric, and Garré in Europe have all described the condition. Jaffe (7) and Lichtenstein have reported a number of cases similar to those described by Albright.

Most authors believe that the term fibrous dysplasia is being applied to several forms of fibrocystic disease that may or may not be pathologically related and which may be divided into four types. The first type is the classical polyostotic disease associated with skin pigmentation and sexual precocity as described by Albright and others (Case IV). The second is the monostotic type, in which all forms of endocrine abnormality are lacking, as are the cutaneous findings (Case V). The third form is the monostotic lesion that arises from the long bones and extremities and resembles the solitary bone cysts of childhood (Case VI). The fourth is an ec-

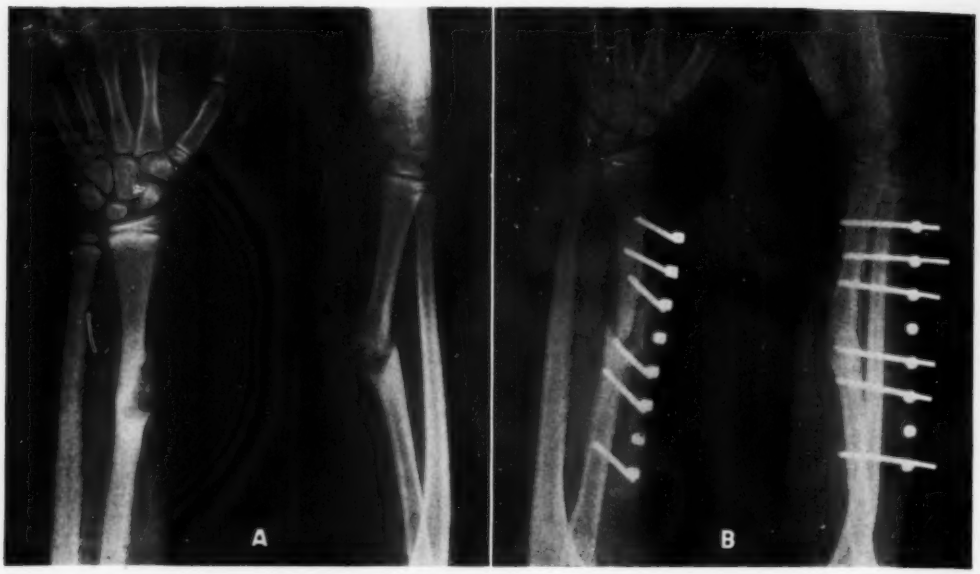

Fig. 6. Case IV: Fibrous dysplasia
A. Anteroposterior and lateral views of right forearm showing fracture through the radius. Note the tendency toward unilateral expansion of the bone.
B. View of same arm following curettement and immobilization.

centrically placed solitary lesion that occurs in the metaphyseal area of long bones, classified by many as a non-osteogenic fibroma of bone. Most of the cases encountered fail to show any precocious sexual development or pigmentation of the skin. The ratio of the lesion associated with endocrine manifestations to the other types has been estimated at 1:30.

CASE IV (Fig. 6): K. H., age 6 years, fell and sustained a relatively trivial injury to the forearm, but enough to cause a fracture (Fig. 6A). She had experienced no pain in the arm prior to this. Cystic changes were present in the bone. The fracture failed to heal following reduction and application of a plaster cast. Open reduction with application of a Clayton bar and bone chips finally gave satisfactory results. The lesion was studied microscopically and a diagnosis of fibrous dysplasia was made.

This case I believe may be similar to those described by Albright. The child's skin, though fair, showed multiple punctate areas of tan pigmentation. She did not exhibit precocious sexual development at the time we examined her. Unfortunately further contact with her was lost.

CASE V (Fig. 7): N. L., a 14-year-old boy, was apparently in excellent health until he fell out of a tree, sustaining a fracture of the left tibia. He stated that he had had no pain in the leg previously. The roentgen examination revealed an oblique fracture of the lower tibia in an osteolytic lesion involving the metaphysis and the shaft. The lesion was not expansile and showed no invasive characteristics. The margins were very distinct. The roentgenologic impression was fibrous dysplasia.

Biopsy showed fibrous dysplasia. Curettement of the affected area and immobilization of the bone resulted in healing of the fracture.

CASE VI (Fig. 8): P. H., a white boy, age 6 1/2 years, was admitted to the hospital complaining of pain in the right hip area. Roentgen examination revealed an expansile type of lesion, cystic in character, that had destroyed the cortex in the subtrochanteric area. The area was curetted and bone chips were implanted. The pathologist felt that the child had a bone cyst.

Serial films following surgery showed that some of the lesion remained, and 1,400 r was delivered to the site of recurrence. This therapy and a subsequent curettement inactivated the process. Re-evaluation of the slides by the pathologist caused him to change the diagnosis to fibrous dysplasia. The patient is getting along well at the present time, although we believe from the roentgenologic standpoint that he may have residual disease.

Most authors feel that the monostotic form of fibrous dysplasia is the most com-

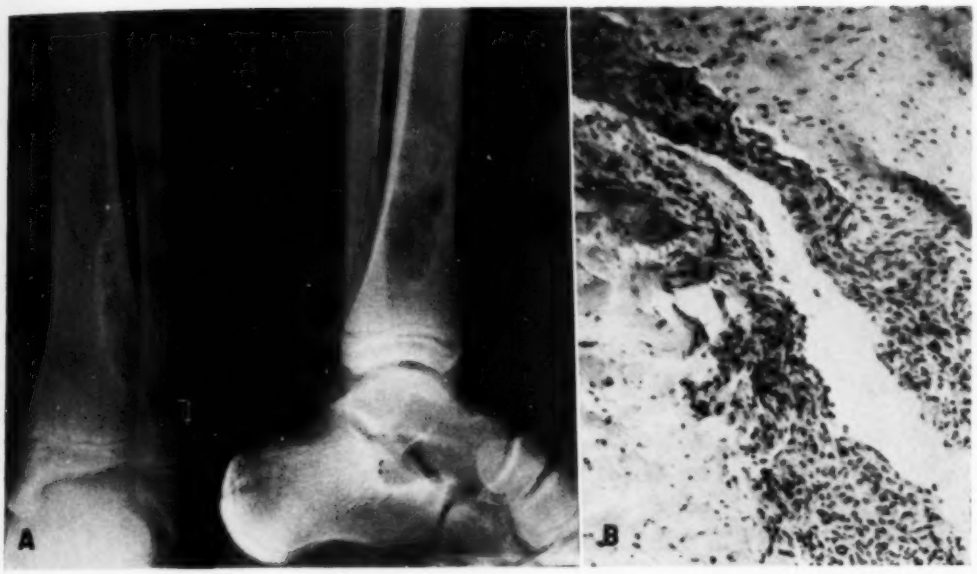

Fig. 7. Case V: Fibrous dysplasia
A. Postero-anterior and lateral projections of left ankle area showing a lytic type of lesion but with considerable condensation of bone along its margins.
B. Photomicrograph of the curettings.

mon. Schlumberger (15) has studied 67 cases at the Army Institute of Pathology involving a single bone, while in only 2 cases were more than one bone affected. In a great majority of the monostotic cases the ribs were involved, though lesions in the femur, tibia, maxilla, mandible, vertebrae, and fibula were also observed. Albright (1) has emphasized the triad of bone lesion, precocious sexual development in the female, and areas of pigmentation of the skin. We have seen only one case (Case IV) which may have been of this type.

The roentgenographic feature of fibrous dysplasia is a broadening or expansion of the bone, with thinning or erosion of the cortex and loss of the trabeculae. The lesion may be centrally (Fig. 8A) or eccentrically placed (Fig. 6A). Roentgenographically the condition may be confused with von Recklinghausen disease, enchondroma, or simple bone cyst (Case VI), and it may be extremely difficult to differentiate between this entity and the cystic disease associated with hyperparathyroidism if only one bone is examined. In its monostotic form, fibrous dysplasia may simulate a chondroma or even a giant-cell tumor. Analysis of the blood serum does not help in the differential diagnosis. The only important points in distinguishing between this and the bone lesions produced by hyperparathyroidism are the predominance of fibrous dysplasia in children, its frequent unilateral or monostotic character, and the absence of multiple bone involvement. It is often necessary, also, to differentiate fibrous dysplasia from metabolic disease of bone such as the Hand-Schüller-Christian type. In the great majority of cases of the latter disease, however, the lesion is more or less punched-out and has less tendency to expand the cortical shell. The patient often will present himself with a pathologic fracture.

Schlumberger's analysis of 67 cases from a pathologic standpoint has not changed the original description. Studying the clinical and roentgenologic aspects, he found the following impressions recorded prior to bone biopsy: bone cyst in 16 instances, giant-cell tumor in 8, osteochondroma in 8, bone tumor in 7, enchon-

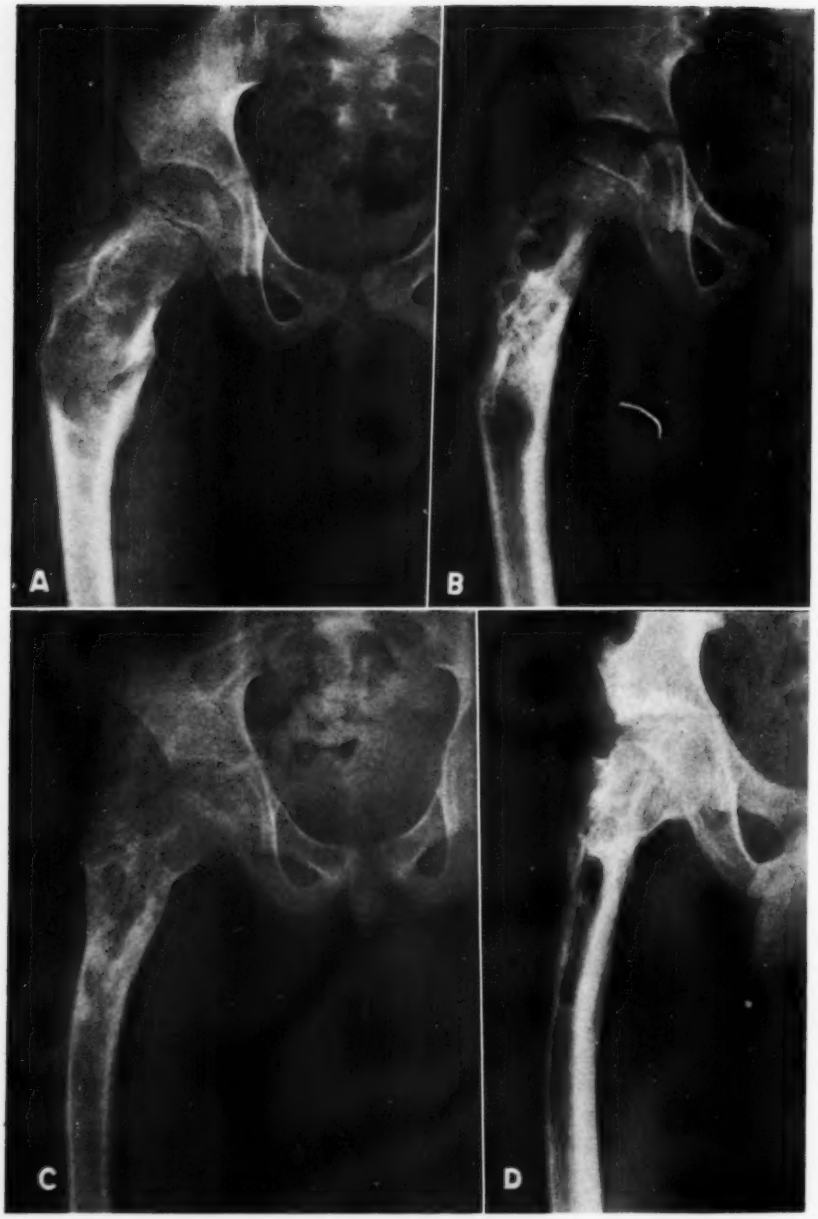

Fig. 8. Case VI: Fibrous dysplasia

A. Anteroposterior roentgenograms of right hip on June 30, 1943. Note the expansile characteristics of the lesion. It resembles a bone cyst. Curettement with insertion of bone chips was done after this examination.

B. Same hip, Nov. 17, 1944, showing residual areas of neoplasm. Total of 1,400 r (in air) was given.

C. Anteroposterior view, Nov. 30, 1946. Some fibrous elements remain.

D. Right hip on Jan. 24, 1951. The patient had no pain at this time. We feel, however, that residual disease is still present.

droma in 4, chondroma, fibroma, osteitis fibrosa cystica, sarcoma, myeloma, and Paget's disease. The inclusion of malignant bone disease in this list implies that a more careful study of bone lesions must be made.

The original pathologic diagnoses that were made by independent pathologists are also of interest. Fibrous dysplasia was diagnosed in 19 instances, osteitis fibrosa cystica in 13, giant-cell tumor in 7, ossifying fibroma in 7, fibrosarcoma in 5, with fibroma and simple bone repair concluding the list. Again, on a pathologic basis, a malignant bone lesion has been mistaken for a benign entity (Case III). This can only imply that clinical, radiologic, and pathologic data must be diligently studied before the diagnosis of any bone tumor can be made.

Microscopically, the lesion of fibrous dysplasia is made up of islets of poorly formed new bone set in a matrix of fibrous stroma, histiocytes, and occasional large multinucleated giant cells. As one would expect, the fibrous elements of the bone predominate (Fig. 7B).

The best treatment is surgical if the whole area can be resected. Bone block dissection is best. Curettage and bone chips have also yielded good results, though it is well to warn that if some of the fibrous tissue is left behind it may form another cystic area fully as large as the one previously encountered (Case VI). Some men have reported malignant change in the regions of fibrous dysplasia.

EOSINOPHILIC GRANULOMA

Eosinophilic granuloma is the third entity that has been reported in the past few years. It apparently is not a specific bone lesion but it does involve bone. It was first described by Lichtenstein (11) and Otani and Ehrlich (13) in 1940. In 1945, Dundon, Williams and Laipply (4) reviewed the literature and found 48 cases recorded. We now feel that the incidence of this lesion is higher than was previously supposed. Many cases have been found in servicemen in World War II.

The exact pathologic classification of eosinophilic granuloma is not known. It can occur (*a*) solely in bone, (*b*) in bone associated with lesions of the lung, lymph nodes, or skin, or (*c*) in the gastro-intestinal tract without bone involvement. Many have attempted to classify it as a form of xanthomatosis of bone and feel that it is a variant of the Hand-Schüller-Christian syndrome. Some authors have stated that it is related to Letterer-Siwe disease. Others have felt that it is simply an abnormal response to an infectious process.

Eosinophilic granuloma may occur at any age but is very common in children and in young adults. Any bone in the body may be affected, the flat bones as well as the long bones. Again the ribs are most commonly involved, but the vertebral column and the long bones are frequent sites of tumor. In its clinical aspect, the disease is mild. Pain of increasing severity over a long period of time is the common complaint. Pathologic fractures do occur and may be the factor leading the patient to consult a physician.

CASE VII (Fig. 9): D. McI., a 5 1/2-year-old boy, gave a history of having been kicked in the head one year previously. The present complaint was headache localized to the occipital region. It had been intermittent during the past four months. Roentgen examination revealed a localized lesion, osteolytic in character, that involved the left occipital area near the midline. The borders were clear and well defined and tended to be sclerotic. The radiologic impression was a benign lesion, probably eosinophilic granuloma or epidermoid tumor of the skull.

Study of the excised lesion showed a classical picture of eosinophilic granuloma (Fig. 9C).

CASE VIII (Fig. 10): A. E., a 9-year-old girl, was admitted to the hospital in December 1937, complaining of pain in the low back over a period of several months. Examination was essentially negative except for a more or less generalized lymphadenopathy. There was no anemia or fever. The laboratory and clinical findings were negative. A destructive process in the third lumbar vertebra was demonstrated roentgenographically (Fig. 10A).

A biopsy of an axillary node was done on two occasions and the pathologist described a lesion packed with lymphocytes and eosinophils. The eosinophilic picture was predominant. No Reid or Sternberg cells could be identified. It was felt that the tissue was not entirely consistent with Hodgkin's disease

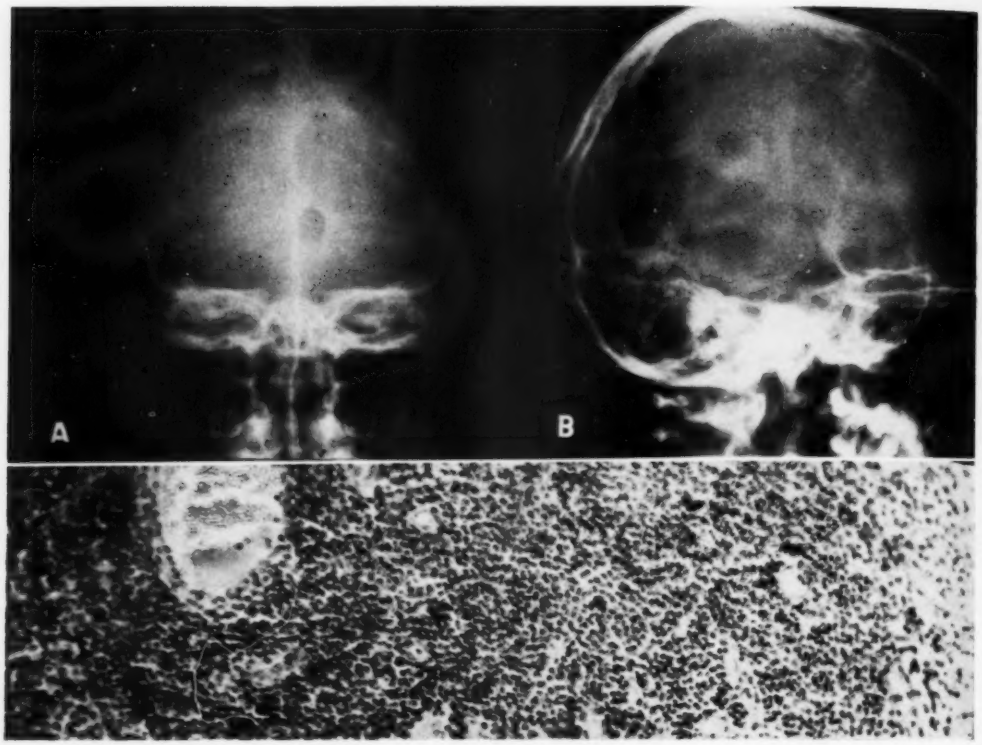

Fig. 9. Case VII: Eosinophilic granuloma
A. Punctate, well defined lesion near the base of the skull, showing no invasive characteristics.
B. Oblique view showing destruction of the outer table.
C. Photomicrograph. The rounded cells represent eosinophils set in sheets of histiocytes.

but possibly a forerunner of it. (At the time eosinophilic granuloma was not considered.)

Radiotherapy was given to the lumbar area and the lymph nodes. All lesions promptly regressed. On review, this appears undoubtedly to be eosinophilic granuloma of lymph node and bone. A roentgenogram shows the collapsed lumbar vertebra well healed (Fig. 10 C). The patient is in excellent health and has borne two normal children.

CASE IX (Fig. 11): M. H., a 14-year-old girl, complained of localized pain in the left chest for approximately four months. It was described as deep and boring, and at first was not aggravated by deep breathing. On questioning, the patient blushingly admitted that it was most severe when her boy friend "squeezed" her. Except for the pain she was in excellent health.

Roentgenograms of the thorax revealed an osteolytic lesion of the eighth rib on the left side. It tended to be expansile. Biopsy was discussed and refused. A tentative diagnosis of eosinophilic granuloma was made. Radiotherapy was given; a total exposure of 600 r caused complete regression of the lesion.

Eosinophilic granuloma may be confused with fibrous dysplasia although the margins of the lesion are not as well defined as in the latter condition. Cartilaginous tumors, the Hand-Schüller-Christian syndrome, multiple myeloma, and angioendothelioma must also be considered in differential diagnosis. Multiple areas of the body may be involved, and recurrence of the tumor in other bones has been reported after the initial diagnosis has been made on a single bone. Some authors (16) have reported spontaneous regressions of known lesions while others report regression after a fracture has occurred.

The pathologic picture of eosinophilic granuloma is classical. The trabeculae and osseous structure of the bone are destroyed and may be replaced by a soft meaty type of tumor; the cortex is thinned and may

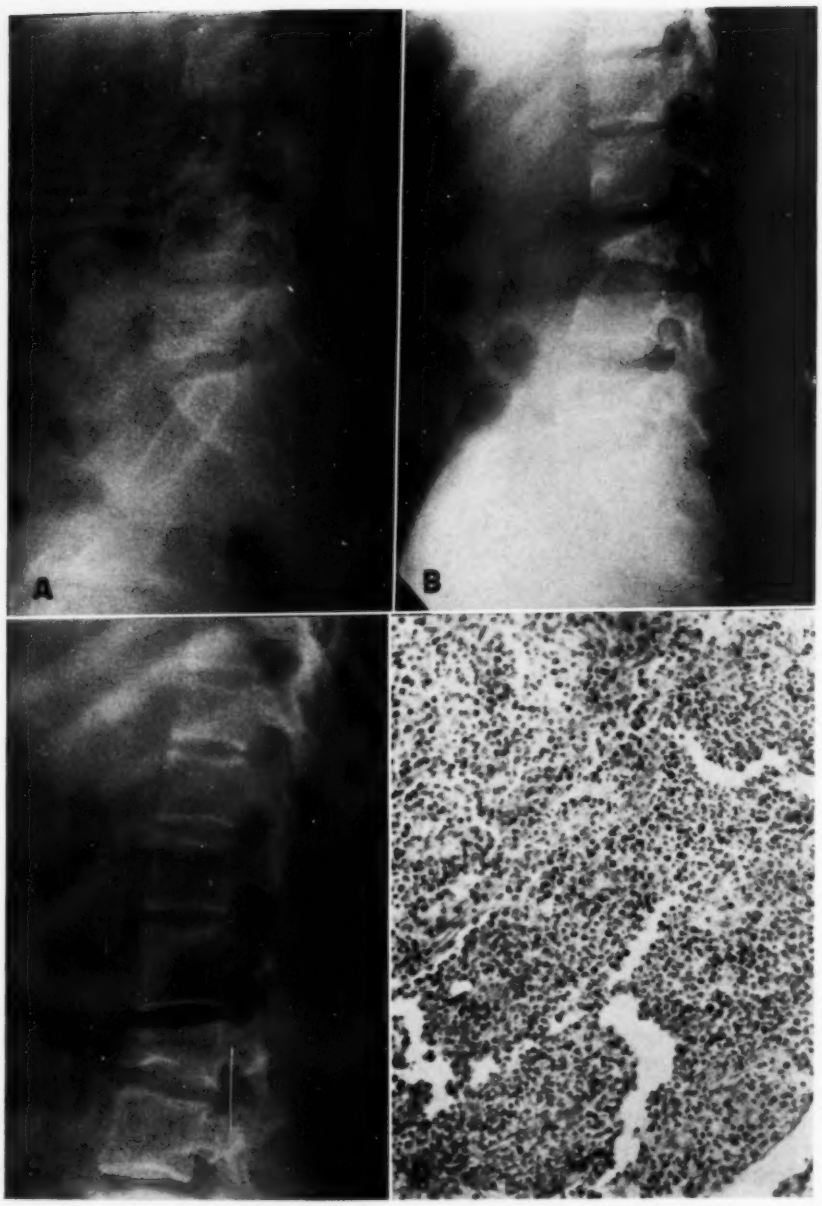

Fig. 10. Case VIII: Eosinophilic granuloma

A. Lateral view of lumbar area showing destructive process in third lumbar vertebra. Radiotherapy was started.

B. Same vertebra approximately two months after radiotherapy.

C. The third lumbar vertebra over three years later.

D. Photomicrograph of lymph node, showing it to be packed with esoinophils.

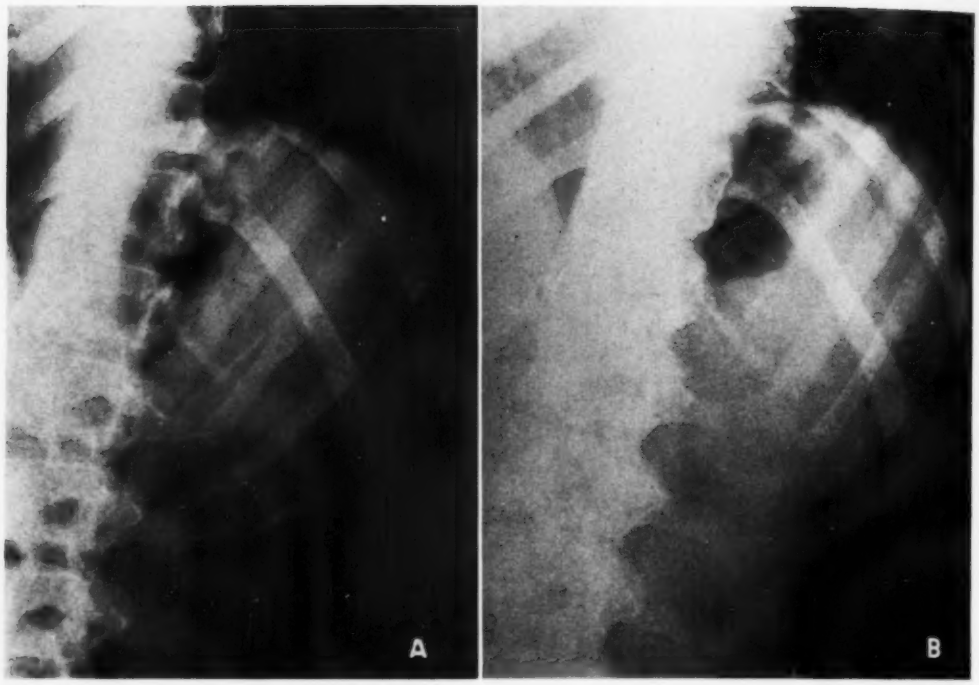

Fig. 11. Case IX: Eosinophilic granuloma
A. Roentgenogram showing a destructive process in the anterior aspect of the eighth rib. Lesion tends to be expansile. Note the fracture.
B. Same lesion approximately five months after radiotherapy.

even be expanded (Case IX). If the disease occurs in the skull, as it often does, it may completely destroy all of the medullary portions of the bone and replace even the inner and outer tables (Case VII).

Dundon, Williams and Laipply (4) have described a soft-tissue granuloma that involved the thoracic wall. Some men feel, also, that the lesion may occur primarily in either the lung or the gastro-intestinal tract, independently. We have seen one case (Case VIII) in which the lymph nodes were involved as well as the lumbar vertebrae. Radiotherapy to the spine and lymph nodes halted the progress of the lesion in that instance.

Histologically eosinophilic granuloma is characterized by a cellular type of tumor showing a little stroma, which is densely packed with eosinophils (Figs. 9C and 10D). Treatment may be by either surgical extirpation or radiotherapy. Most lesions are removed surgically or curetted at the time a biopsy is done. However, the lesion can be completely destroyed by irradiation, 400 to 600 r to the tumor.

CONCLUSION

We have briefly discussed some of the bone lesions encountered in childhood which have become popularly known within the past decade, and have reported examples. It seems rather paradoxical that in one of the easiest systems of the body to examine radiographically a correct analysis should present such difficulty. Until more is known about the physiology of bone and its component cells, it seems inevitable that we shall continue to make errors in the diagnosis of bone tumors. Until that time arrives, our best method of attack is careful and complete collaboration between the orthopedist, the pathologist, and the radiologist. The radiologist is

shirking his duty if he will not evaluate the clinical aspect of the case, analyze his roentgenograms in the light of the history, and attempt to arrive at a clinical impression.

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SUMARIO

Observaciones en Tumores Oseos Benignos en la Práctica Pediátrica

Repasáronse 412 tumores óseos en niños con mira a correlacionar los hallazgos radiológicos y patológicos y a reclasificar algunos del grupo, considerando tres entidades morbosas reconocidas más recientemente, o sean: osteoma osteoideo, displasia fibrosa y granuloma eosinófilo.

El osteoma osteoideo tiene que ser diferenciado de la osteomielitis crónica o esclerosante, del osteosarcoma atípico y del endotelioma óseo. Constituyen características diferenciales el patrón topográfico bien localizado del tumor y la falta de verdadera osteólisis.

La displasia fibrosa reviste varias formas: (1) poliosteótica, asociada con pigmentación cutánea y precocidad sexual, (2) monoosteótica, sin disendocrinias; (3) monoosteótica, originada en los huesos largos y semejando un quiste óseo solitario; (4) lesión solitaria colocada excéntricamente en la zona metafisaria de los huesos largos. Radiológicamente, puede confundirse el estado con la enfermedad de Recklinghausen, el encondroma, el quiste óseo simple, la enfermedad quística asociada con el hipertiroidismo y las lesiones de la enfermedad de Hand-Schüller-Christian. La diferenciación del hipertiroidismo se basa en el predominio de la displasia fibrosa en los niños y su frecuente naturaleza unilateral y monoosteótica. Las lesiones de la enfermedad de Hand-Schüller-Christian son más o menos excavadas y muestran menos tendencia a dilatar la corteza.

El granuloma eosinófilo puede ser confundido con la displasia fibrosa, aunque los bordes de la lesión no están tan bien definidos como en la última. También hay que diferenciar de los tumores cartilaginosos, la enfermedad de Hand-Schüller-Christian, el mieloma múltiple y el angioendotelioma.

Preséntanse casos típicos de las tres entidades descritas.

Wilms' Tumor of Infancy and Childhood

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WHEN ONE REFERS to malignant disease of the kidney in infancy and childhood one is referring to Wilms' tumor, as other types of renal neoplasms, such as hypernephroma, are practically unheard of in the early years, although Wilms' tumor is reported with some frequency in adults.

The term "Wilms' tumor" has been selected from the host of synonyms for this neoplasm, which constitutes about 20 per cent of all malignant tumors of childhood, as it is the most familiar designation and the one in most common use. In reviewing the literature, it is surprising to find how many of these cases are hidden under such names as carcinosarcoma, adenosarcoma, embryonic adenosarcoma, embryonic nephroma, malignant nephroma, myosarcoma, adenomyosarcoma, rhabdomyoma, nephroblastoma, spindle-cell sarcoma, and mixed tumor. The wealth of descriptive terms for this single lesion reflects the varied histologic picture that it may present.

The clinical and pathologic aspects of the tumor are firmly settled, the two points of controversy being the pathogenesis and the treatment. This paper will not attempt to resolve either of these disputes. Facts and figures from the literature and from personal experience will be presented, and the reader may reach his own conclusions.

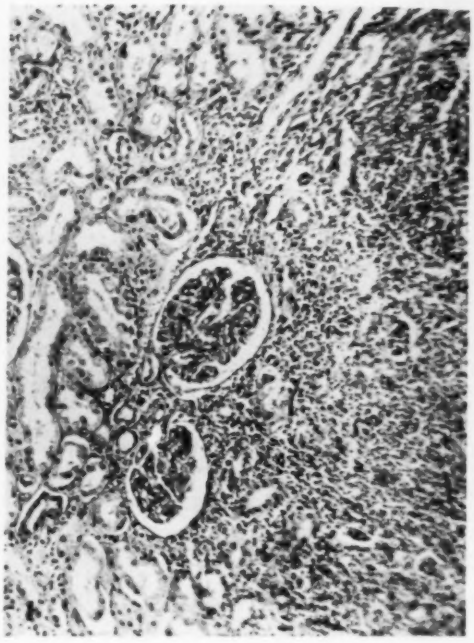
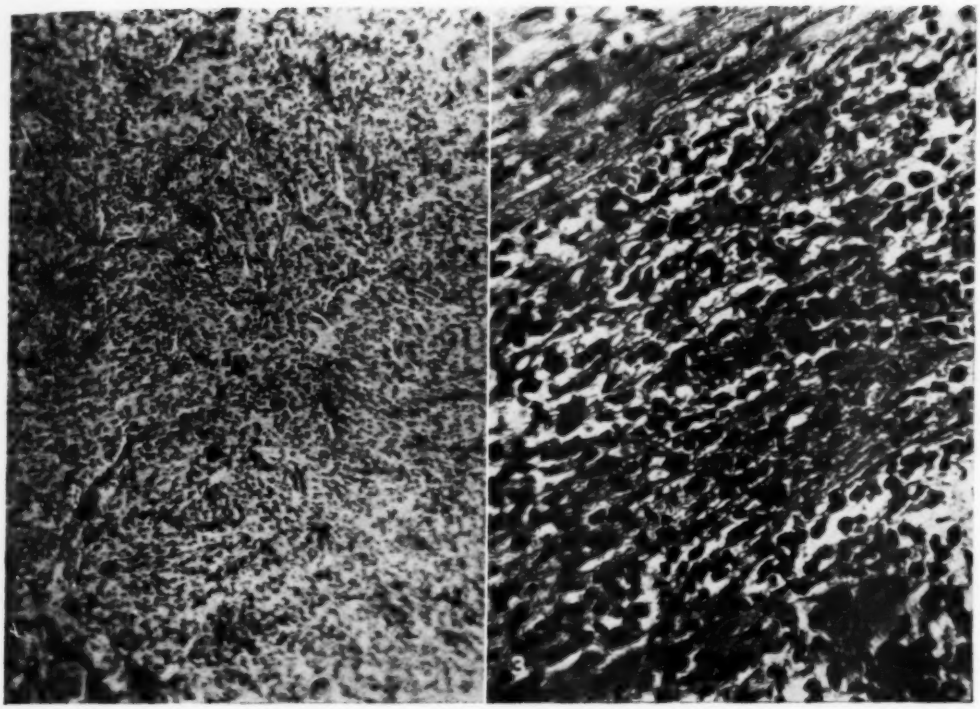


Fig. 1. Kidney parenchyma being invaded by small, round and oval undifferentiated embryonal cells from a tumor that grossly appeared well encapsulated.

HISTOGENESIS

The earliest conception of Wilms' tumor was that it was a carcinoma, its mixed nature first being recognized by Eberth in 1872. It was his opinion that the tumors arose from inclusions of the wolffian body within the developing kidney. A little later in the same century Cohnheim came forward with his cell-rest theory; he believed that the origin was from aberrant germ plasm, the multiple potentialities of the cells accounting for the wide range of tissues found in the tumors. Some time later, other investigators advanced the theory that the neoplasms were of endothelial origin and that the various tissues observed in them were the result of a metaplasia on the part of the endothelial cells. A derivation from the nephrotome, the anlage of the wolffian body, has also been suggested, but this theory leaves some unanswered questions. The nephrotome is a well developed embryonic structure and one can see how it might

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.



Figs. 2 and 3. Case III. Fig. 2 shows small undifferentiated cells arranged in a more or less solid sheet. In Fig. 3 embryonal cells are seen assuming a strand-like arrangement but with no attempt at the formation of recognizable structures.

be responsible for the acinar, tubular, and abortive glomerular structures of the kidney, but it is difficult to imagine it giving rise to such tissues as muscle, fat, cartilage, or bone. The most logical idea seems to be that proposed by Wilms in 1899. He reasoned that, since a variety of tissues enter into the make-up of these neoplasms, they must arise from a very embryonic type of cell that has multipotentialities for forming various tissues and structures. Such a cell is found in the embryo prior to the formation of the nephrotome. It is an undifferentiated mesodermal cell which in the normal course of development gives rise to (*a*) the myotome, which is the source of striated muscle, (*b*) the sclerotome, which is the source of the axial skeleton and ribs, and (*c*) the nephrotome, which is the anlage of the kidney. Thus we have a cell which normally gives rise to every type of tissue that has been reported in a Wilms' tumor. If some of this young and undifferentiated mesoderm becomes incorporated in the developing kidney, it may, under the proper stimulus, launch into unrestrained growth. If the impetus for abnormal proliferation comes in fetal life, the resulting neoplasm will be present in the newborn infant; if it comes in later life, an adult type of Wilms' tumor will result.

PATHOLOGY

Wilms' tumors are rapidly growing and are usually silent until they induce symptoms by their mechanical effects, so that they may reach a tremendous size before being discovered. Examples have been reported weighing as much as 5,000 gm. and measuring up to 40 cm. in diameter. They are fairly well encapsulated, which demarcates them from the renal parenchyma, but the capsule is tightly adherent to the renal

tissue and cannot be separated from it without tearing away some of the kidney substance. The surface may be smooth or lobulated and, while some of the tumors are fairly soft, others are quite hard and fibrous. They may arise from any portion of the kidney, although it is repeatedly stated in the literature that they are more common at the lower pole. In 4 of the 8 cases presented here the origin was definitely from the lower pole. It is also possible for the tumor to be completely separate from the kidney, as in 2 cases of this series. This occurs when the tumor anlage is not incorporated within the developing kidney but lies adjacent to it in the perirenal tissues.

The cut surface of the tumor is glistening. The color, which is more or less uniform in the smaller tumors, varies from a grayish-white or pink to brown. In the larger specimens one may encounter areas of discoloration due to hemorrhage and fatty or myxomatous degeneration. In one of the largest of the observed tumors there was a soft gelatinous center, a finding that has been fairly common in cases reported elsewhere. One tumor in the group showed an amorphous calcification scattered throughout. According to Dickey and Chandler (7) the finding of calcification in the tumor is a favorable prognostic sign. They reported 12 cases with 4 cures of four, eight, ten, and fifteen years respectively. In 3 of the 12 cases there was calcification within the tumor, and all 3 of these patients were cured, accounting for 3 of the 4 survivals.

None of the tumors in the present series was bilateral, although the statement is made in the literature that there is a tendency to bilateral occurrence (27, 30).

Microscopically one finds that the apparently well encapsulated tumor may actually be invading the kidney substance (Fig. 1). In the cases under observation the predominant cell was in most instances a highly undifferentiated, hyperchromatic, round, oval, or spindle cell, and it was often difficult to decide whether these were of carcinomatous or sarcomatous type. In some sections these cells were arranged in almost solid sheets (Fig. 2); in others they assumed a strand or cord-like arrangement (Fig. 3); in still others one would find a paucity of these undifferentiated cells lying in the midst of a dense connective-tissue stroma (Fig. 4). The amount of stromal tissue varied from tumor to tumor and from section to section in the same tumor. In some areas the quantity of stromal elements was so small as to be almost imperceptible (Fig. 5), while elsewhere the stroma seemed to form the major portion of the tissue (Fig. 6). In only one instance in the present series was there any attempt at tubular or glomerular formation, and this was of a very abortive character (Fig. 7). Muscle cells were identified in 2 of the observed cases but constituted an inconspicuous part of the over-all picture (Fig. 8).

One usually finds both epithelial and connective-tissue structures in these tumors in varying proportions. Many tumors will contain glandular tissue, which may form well defined tubules and glomeruli or very abortive and immature renal structures (Fig. 9). There is also a tendency toward rosette formation in the majority of cases. Along with the immature epithelial elements, one finds embryonal mesenchymal tissue, from which the fibrous tissue, fat, cartilage, muscle, and bone sometimes encountered in these neoplasms is derived. This embryonic connective tissue may be predominant and surround the less numerous epithelial structures. The muscle tissue often present may be of the striated or non-striated variety, and in some instances may be the major tissue of the tumor. Ectodermal and endodermal structures, such as skin, alimentary and respiratory tissues are never found.

According to Willis (30), invasion of the veins by Wilms' tumors is conspicuous, blood-borne metastases being most common in the lungs and liver, and less frequently reported in the skin, bones, and brain. Once the capsule is ruptured, local spread takes place promptly and adjacent structures such as the kidney hilus, renal

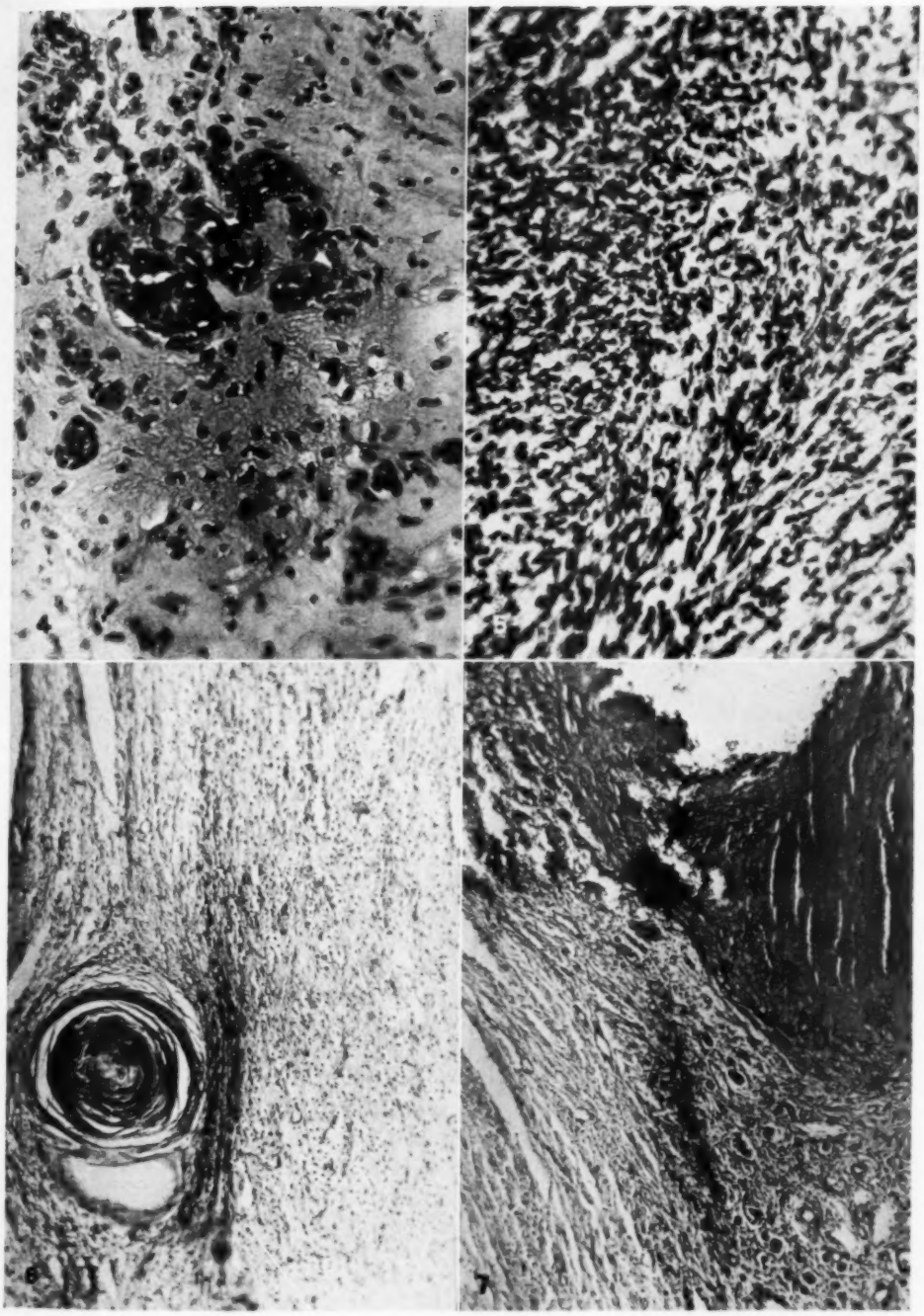


Fig. 4. Case VII: Scattered tumor cells lying in a dense, hyalinized connective tissue. In the center of the section are solid epithelial collections that probably represent an attempt at tubule formation.
Fig. 5. Case V: Masses of tumor cells supported by a fine, lace-like connective tissue stroma.
Fig. 6. The major portion of the tissue here is connective tissue. To one side of the section there appears to be an attempt at pearl formation.
Fig. 7. Case IV: The lower right portion of the section shows an attempt at tubule and glomerulus formation. Above this is an area of hemorrhage.

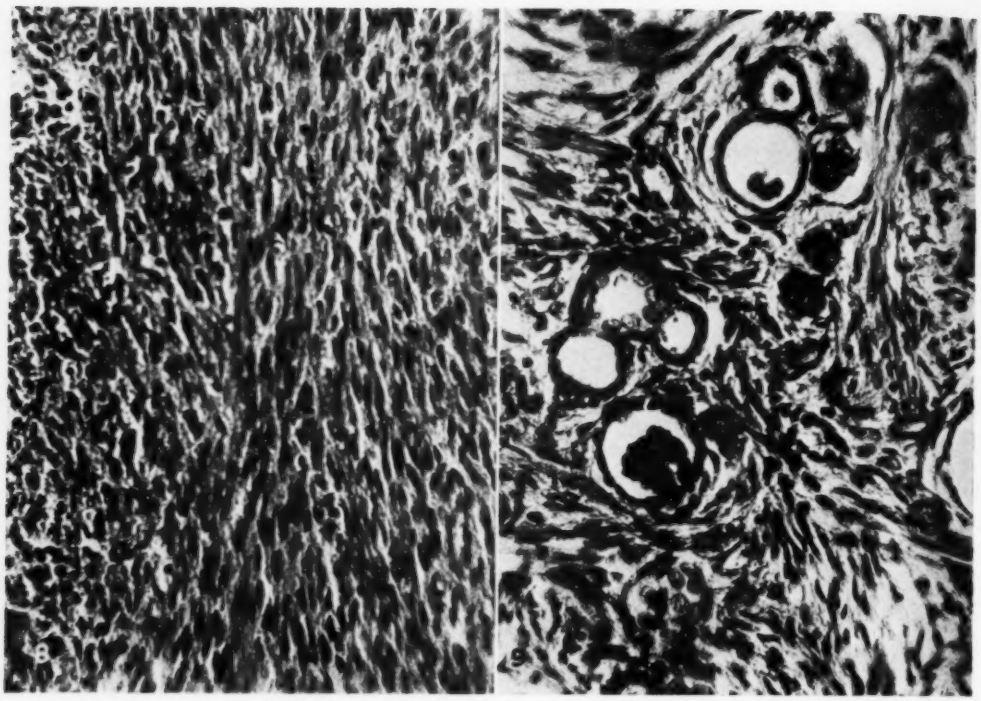


Fig. 8. Case VIII: Muscle cells in a highly cellular tumor.
Fig. 9. Well defined and easily identifiable yet immature tubules and glomeruli.

vein, inferior vena cava, peritoneum, duodenum, ureter, and lymph nodes may be rapidly invaded.

HISTORY AND PHYSICAL FINDINGS

The average age of the child with a Wilms' tumor will be about three years, although cases have been reported in the newborn and in the adult. Something like 80 per cent of the cases occur before the age of eight. The youngest child in this series was twelve months and the oldest eight years. The sexes are affected about equally, and the incidence of right- and left-sided involvement is approximately the same.

By far the most common symptom and physical finding is an abdominal mass that has shown a progressive and painless enlargement. This was the presenting complaint in 7 of the 8 cases to be recorded here. The mass is non-tender and may fill an entire half of the abdomen. According to Gross and Neuhauser (10), there is a tendency for these tumors to be limited to one side of the abdomen, whereas the neuroblastoma tends to cross the midline, which may serve as a point of differentiation between the two.

Because of the encapsulation of the tumor, hematuria does not occur early, although in a small percentage of the cases it may be the presenting complaint. It is usually regarded as a late symptom and its presence carries a poor prognosis. Oddly enough, one of the two cures reported here was in a child seven years of age, whose chief and only complaint was hematuria, the mass not being discovered until she entered the hospital. So, although the prognosis may be poor in the presence of hematuria, it is by no means hopeless.

Fever is a common finding and was present in 6 of the 8 cases. It may be intermittent or of the continuous typhoidal type. None of the patients complained much of

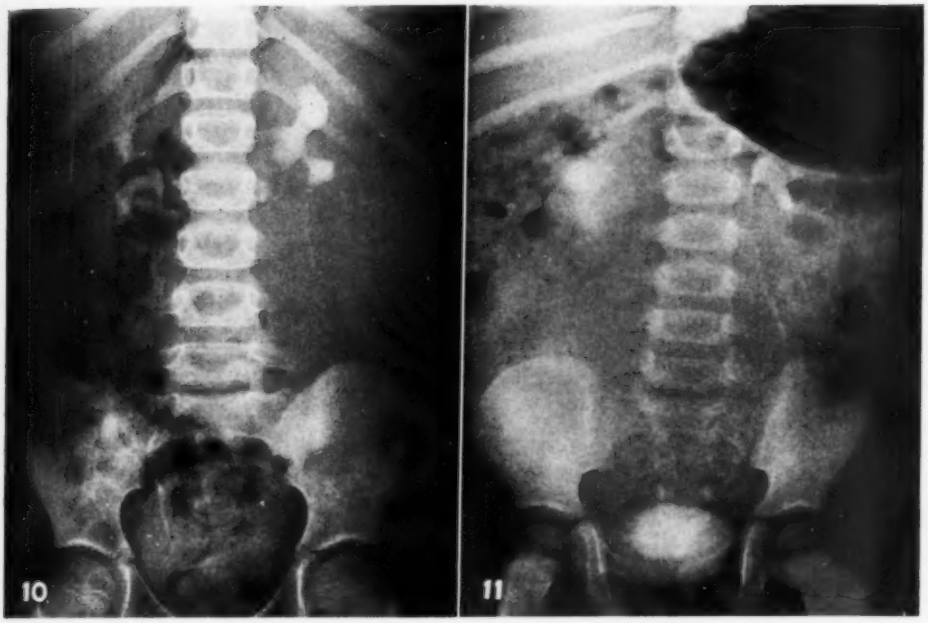


Fig. 10. Case VII: A large left abdominal mass displacing intestinal gas shadows to the right and showing calcification in its lower portion above the left iliac crest. The tumor in this case arose from the lower pole of the kidney.

Fig. 11. Case V: A large right abdominal mass extending across the midline and displacing the ureter of the normal side laterally. There is hydronephrosis of the involved side, the main tumor mass lying inferior and medial to the lower pole of the kidney.

pain, but rather of a vague abdominal distress, which they described as more of an ache than a pain. Loss of weight was not prominent when the children were first seen, most of them appearing fairly well nourished.

Other symptoms and findings that may appear, due principally to the mechanical presence of the mass or its metastases are anorexia, vomiting, constipation, irritability, pallor, and enlarged tortuous superficial veins over the abdomen and lower thorax. Numerous authors have described a hypertension accompanying these lesions, but no hypertension was encountered in this series. The elevated blood pressure is presumably due to renal ischemia or to the release of a pressor substance by the tumor.

Urinary symptoms are conspicuous by their absence, although in addition to the hematuria one of the children under discussion complained of frequency.

LABORATORY FINDINGS

The laboratory is not of much assistance in making a diagnosis of Wilms' tumor. Most of the patients show a mild secondary anemia with a hemoglobin between 60 and 70 per cent and a red cell count of 3,000,000 to 4,000,000. There is usually a slight leukocytosis, in the neighborhood of 10,000, but normal white counts are frequently obtained. Examination of the urine may demonstrate the presence of microscopic blood.

ROENTGENOGRAPHY

A definite and conclusive diagnosis of Wilms' tumor cannot be made from the roentgen studies alone, as there is no deformity or displacement sufficiently characteristic to single out this particular lesion to the exclusion of all others. Pyelography, however, is an essential aid and, when combined with the history and physical findings, will make the diagnosis al-

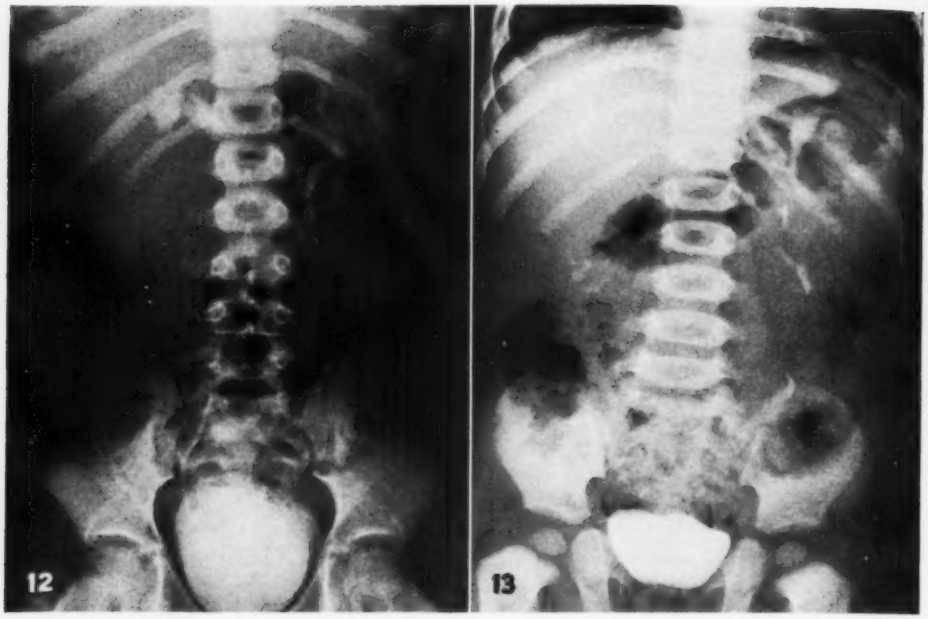


Fig. 12. Case IV: A large tumor arising from the lower pole of the right kidney, displacing the ureter medially and the kidney upward and medially. The pelvis and calyces are distorted and stretched over the top of the tumor.

Fig. 13. Case III: A left-sided tumor 6 cm. in diameter, not attached to the kidney and not impinging upon it, and hence producing no distortion of the collecting system. The tumor lay inferior, medial, and anterior to the kidney and had invaded about the aorta. It displaced the left ureter laterally at the level of the iliac crest, which was the only indication of its presence.

most certain. As a rule, intravenous pyelography gives all the necessary information and retrograde studies, which are not too desirable in this age group, can be omitted. In the present series of cases adequate visualization was obtained in every instance by the intravenous or intramuscular route, although it is true that, where satisfactory visualization is not obtained, the retrograde route will have to be used.

The preliminary flat plate of the abdomen will usually demonstrate the tumor. There may be displacement of the intestinal loops to one side (Fig. 10) or, in the case of very large tumors, one may find elevation of the diaphragm on the affected side and bulging of the flank. The calcification that occurs in a certain percentage of these tumors may also be visualized (Fig. 10). With the abdominal flat plate one should, of course, obtain a chest film to rule out metastasis.

The character of the urographic findings will depend upon the size, location, and metastatic spread of the tumor. Most of the effects will be due to mechanical pressure rather than to actual invasion and destruction, for, as has been noted, the neoplasm is usually well demarcated from the renal parenchyma. There may be no visualization on the affected side or visualization may be normal. The pelvis and calyces may be distorted, with or without displacement. If the ureters are visualized, they may show displacement on the normal side (Fig. 11), due to extension across the midline, or on the affected side. Ureteral displacement on the affected side may be either medial (Fig. 12) or lateral (Fig. 13), the former being more common.

The displacement of the kidney may be upward, downward, lateral, or medial, depending upon the location of the mass, *i.e.*, whether it arises from the upper pole, lower pole, or mid-portion. Upward and medial displacement is the usual finding

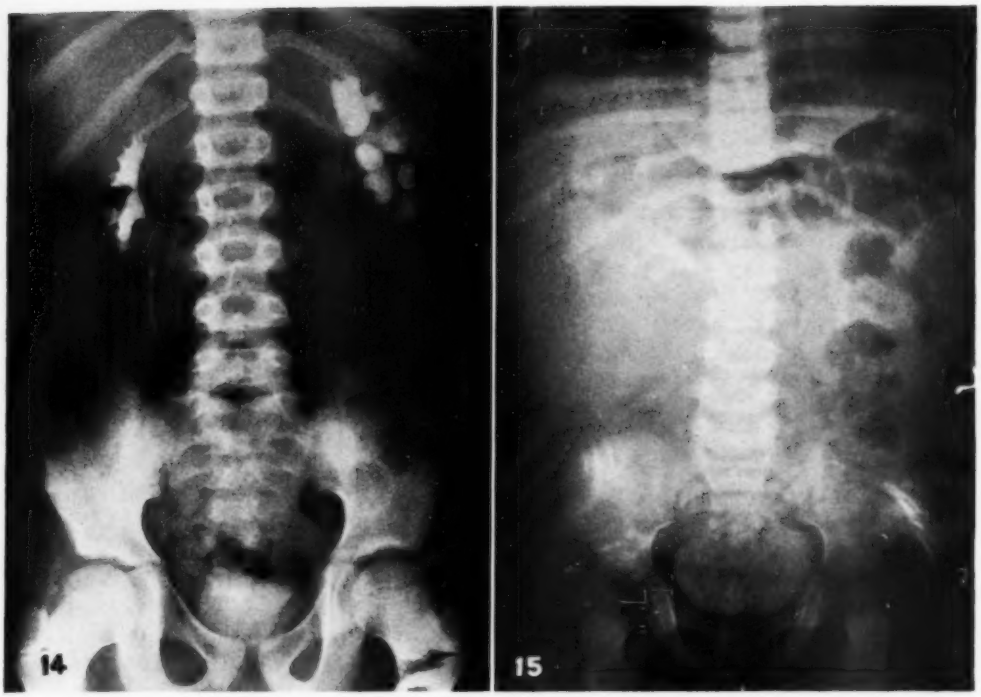


Fig. 14. Case VI: Tumor arising from the inferior and medial aspect of the left kidney and producing rotation and lateral displacement of the kidney. The only distortion of the pelvis and calyces is that due to the hydronephrosis.

Fig. 15. Case VIII: A tumor arising from the lower pole of the right kidney, the chief defect being a flattening and broadening of the inferior calyx, since it is the structure most closely adjacent to the tumor. In addition, there is medial displacement of the ureter.

(Fig. 12). Two of the 8 cases under observation showed lateral displacement of the kidney, which is somewhat rare. In one case the tumor was not connected with the kidney but lay between the lower pole and the spine, displacing the lower pole laterally. In the other case the tumor arose from the medial margin of the kidney between the lower pole and the hilus (Fig. 14). Neuroblastoma is more apt to displace the kidney laterally than is Wilms' tumor, and in the literature this is mentioned as a point in the differential diagnosis.

The type and degree of distortion of the pelvis and calyces will of course depend upon the position and size of the tumor. A tumor arising from one of the poles may not impinge upon these structures and hence no compression changes will be noted (Fig. 13). Only a single calyx adjacent to the growth may show evidence of distortion (Fig. 15), or the entire kidney collecting system may be flattened, elongated, and distorted as it is stretched over the tumor (Fig. 12).

Sometimes the picture is that of hydronephrosis (Figs. 11 and 14), and one not acquainted with the clinical history may overlook the tumor as the cause. Neoplasms arising from the lower pole or medial aspect of the kidney may involve the ureter or the ureteropelvic junction early, with the production of a hydronephrosis, or they may produce a hydronephrosis indirectly by dragging the kidney downward with their weight.

DIFFERENTIAL DIAGNOSIS

There are a number of lesions that may be confused with Wilms' tumor either on

the urogram or on physical examination. In the differential diagnosis one must consider suprarenal tumors, hydronephrosis, polycystic disease, splenomegaly, hepatomegaly, pancreatic cysts, retroperitoneal tumors such as lymphosarcoma, ovarian tumors, and psoas abscess. Kerr (13) cites a case in which a retroperitoneal lymphangioma was mistakenly diagnosed as a Wilms' tumor.

PROGNOSIS

The prognosis in Wilms' tumor is poor, and death is apt to occur from twelve to eighteen months after the patient's first admission. Various authors have placed the mortality at from 80 to 100 per cent. Reviewing the literature over the past twenty years, however, one is immediately struck by the marked improvement in the survival figures reported in the period 1940–50 in comparison to those cited in 1930–39. Pohle and Ritchie (20), in 1935, reported 6 cases with 1 cure, a survival rate of 17 per cent. In the same year Priestley and Broders (22) reported 44 cases with 4 cures, a survival rate of 9 per cent. In 1938 Kretschmer (14) reported 24 cases with 3 cures, or a survival rate of 12.5 per cent. The improvement in the cure rate in the past ten years is exemplified by the following statistics: Nesbitt and Adams (18) in 1946 reported 16 cases with 8 cures (50 per cent); Bixler, Stenstrom and Creevy (2) in 1944 reported 13 cases with 3 cures (23 per cent); Dean (6) in 1945 reported 20 cases with 5 cures (25 per cent); Dickey and Chandler (7) in 1949 reported 12 cases with 4 cures (33.3 per cent). Probably the most impressive figures relative to the improving prognosis come from Gross and Neuhauser (10), from the Children's Hospital in Boston. Their 96 cases are divided into three periods. From 1914 to 1930 there were 27 cases with 4 cures, or 14.9 per cent. From 1931 to 1939 there were 31 cases with 10 cures, or 32.2 per cent. From 1940 to 1947 there were 38 cases with 18 cures, or 47.3 per cent.

Recurrences usually make their appearance in six to eighteen months, although they have been reported as late as four years postoperatively. This, however, is the exception rather than the rule, and, if the child survives two years without evidence of recurrence, there is a good probability of a cure.

The histology or cell type of the tumor apparently has no relation to its curability, nor does its size, as cures have been reported with tumors of tremendous dimensions. The age of the patient, however, seems to have a very definite effect upon the outcome. In studying the reported cases, it is clearly evident that the younger the child the better the outlook. Referring again to the figures of Gross and Neuhauser, one finds that from 1940 to 1947 they had 80 per cent probable cures in patients under twelve months of age, while in patients above that age the probable cure rate was only about half that figure, or 43.3 per cent. The longest survival period in the cases presented here (seven years) was in a patient thirteen months old when treated.

The prognosis should be guarded. Some apparently well encapsulated and readily removable tumors may spring up with local recurrence or metastasis months or years later. On the other hand, seven-, ten-, and twelve-year cures have been reported in inoperable cases in which surgery was confined to biopsy and was followed by roentgen therapy. Case III in the present series is a case in point. The left-sided tumor could not be removed because of involvement about the abdominal aorta. A biopsy was taken, the abdomen was closed, and roentgen therapy was administered. The child is alive and well seven years later. Even bilateral neoplasms do not offer a hopeless prognosis. Gross and Neuhauser report a case of bilateral tumor, treated by nephrectomy on the right and roentgen therapy on the left, the patient being alive and healthy nine years later.

TREATMENT

The treatment may consist of surgery alone, roentgen therapy alone, roentgen

therapy followed by surgery, surgery followed by roentgen therapy, or roentgen therapy both before and after surgery. Each method has its supporters and its statistics, but there seems to be a fairly general agreement that neither surgery alone nor irradiation alone is sufficient, but that a combination of irradiation and surgery is the treatment of choice. The controversy that exists is in relation to the role of preoperative irradiation and prophylactic irradiation of the thorax. There is little argument concerning the importance of postoperative therapy over the kidney fossa, and none at all concerning the importance of intensive irradiation to the local inoperable lesion. Most are agreed, also, that fairly intensive irradiation of metastases is indicated, although the response of these lesions is generally far below that of the primary growth.

The advocates of preoperative irradiation feel that it is indicated for the following reasons: (1) Large tumors may be reduced to a size that makes their removal easier and thereby lessens shock and surgical mortality and may even convert an inoperable mass into an operable one. (2) With the size of the mass reduced, there will be less handling and manipulation during surgery and hence less likelihood of tumor emboli being loosed into the blood stream. (3) By the production of vascular occlusion and fibrosis, some routes for the spread of metastases will be closed off. (4) During the course of preoperative irradiation the patient can be better prepared for surgery. (5) The irradiation will serve as a diagnostic aid.

The antagonists of preoperative roentgen therapy are of the opinion that delaying surgery jeopardizes the patient's chance for survival, since there is no proof that x-rays hinder or prevent metastasis. During the period of waiting for surgery, malignant cells may enter the blood stream; no one can predict when metastasis is going to occur, and to obtain a cure the tumor must be removed before this takes place. Ladd and White (15) conjecture that inducing liquefaction and necrosis in the tumor may even facilitate the spread of metastases. Of their 14 cured patients, only 1 received preliminary irradiation. In studying tumors that had been subjected to irradiation, Priestley and Broders (22) found viable tumor cells amidst the debris and necrosis induced by the irradiation. In addition to the above arguments against preoperative irradiation, it is felt that it may have untoward systemic effects that will delay surgery, or that, because of the temporary relief afforded by the treatment, the patient may in some instances refuse subsequent operation.

It cannot be denied that irradiation has a tremendous effect upon some of these tumors and it should be used, whether before surgery, after surgery, or both. It certainly should not be withheld in the inoperable case, no matter how black the outlook may be. One patient in this series (Case III) is again recalled as being alive and healthy seven years after being declared inoperable because of spread of the disease about the aorta. McNeill and Chilko (17) report a three-year cure in a boy of fourteen months who received only roentgen therapy. Dean (6) treated 20 patients with x-rays only, and 5 are alive and well after five years. Dickey and Chandler (7) report a survival of eight years in a case declared inoperable and given roentgen therapy. Pohle and Ritchie (20) report a cure in a ten-month-old infant who was explored and declared inoperable. Sauer (25) records a ten-year cure in a child who was declared inoperable following exploration at the age of two. Nesbitt and Adams (18) also had a ten-year survival following the pronouncement of inoperability. Bixler, Stenstrom and Creevy (2) present the case of a child who had the primary lesion treated by x-rays alone and within a year had a metastasis in the left apex and one in the right base. The metastatic lesions disappeared following irradiation and the patient was alive and well three years after the original treatment.

The above examples are not cited with the idea of advocating x-ray therapy alone

for Wilms' tumor but merely to stress the potent effect that it may exert.

Preoperative irradiation is not aggressive, the aim being to reduce the size of the mass without delaying surgery any longer than is absolutely necessary. The dosage and protraction vary among different therapists. One plan of treatment that seems to be used rather frequently employs only lateral and posterior ports, the anterior port being omitted to save the skin for subsequent surgery. At 200 or 250 kv., 100 r in air is administered daily to each of the two ports for a total of 1,000 r (air) to each port. This routine requires but ten treatment days, and surgery can follow immediately. Some writers defer surgery for four to six weeks. Goddard (9) is of the opinion that a total of 4,000 r (air) should be administered preoperatively. Randall (23) uses but 800 r (air) to each of two ports, anterior and posterior. Rowe and Fraser (24) deliver 3,500 to 4,000 r on the skin through four to six portals and advise surgery in four to six weeks. Pohle (20) has given some very small doses preoperatively, as little as 500 r in one case and 1,200 r in another.

There is little or no controversy concerning the importance of postoperative irradiation, although there is some difference of opinion as to the quantity to be administered. In Case IV of this series (seven-year survival) the postoperative dose was 1,000 r (air) to each of three ports, anterior, posterior, and lateral, 100 r (air) being administered to one port daily with the following factors: 200 kv., 10 ma., 50 cm. distance, Thoraeus filter, h.v.l. 1.95 mm. of copper. Jacox and Cahill (21), using three portals, administer 100 to 200 r (air) daily, rotating the ports, for a total of 2,400 to 3,000 r (air) per port and an estimated tumor dose of 4,000 to 5,000 r. Their factors are: 200 kv., filtration of 0.5 mm. copper and 1 mm. aluminum, h.v.l. 0.9 mm. of copper, target-skin distance 50 cm. Bixler, Stenstrom, and Creevy (2) administer 1,500 r (skin) to each of three portals in daily increments of 200 r for an estimated tumor dose of 2,500 to 3,000 r.

CASE REPORTS

CASE I: G. O., an 8-year-old white boy, was admitted June 16, 1930, with a left upper quadrant mass of four months duration. He had received an undisclosed quantity of radiation on two occasions prior to admission. The mother stated that during the first course the tumor diminished markedly in size but reappeared three months later, with abdominal pain, and did not decrease in size when roentgen therapy was repeated. The patient died six days after admission, and necropsy disclosed a Wilms' tumor of the left kidney, about the size of a cocoanut, with invasion of the left ureter, pancreas, aorta, and peritoneum and metastases in the liver.

CASE II: J. M., a white girl 3 years of age, was admitted Oct. 10, 1932, the chief complaint being a gradual and painless enlargement of the abdomen for six months prior to admission. Examination revealed a firm, smooth mass filling the left abdomen. The mass did not move with respiration. Urine showed no red cells but a trace of albumin. The hemoglobin was 79 per cent, the red cell count 4,000,000, and the white count 12,400. The temperature was 100° C. At surgery the left kidney was found embedded in a large, grayish-white, rather firm tumor, and both were removed. The pathologic diagnosis was Wilms' tumor. A generalized peritonitis and erysipelas of the abdominal wall developed, and the child died on the seventh postoperative day. Postmortem examination revealed invasion of the local lymph nodes by the tumor.

CASE III: C. S., a white boy 13 months of age, was admitted April 24, 1944, with a mass in the left abdomen. The hemoglobin was 70 per cent, the red cell count 3,500,000, and the white count 10,600. The urine was negative. Pyelograms (Fig. 13) showed a normal kidney and psoas shadow on the left, with prompt filling of the pelvis and no gross abnormalities. The left ureter was displaced laterally. On May 4, 1944, the left kidney was exposed surgically and found to be normal. Anterior, medial, and inferior to the kidney was a mass 6 cm. in diameter that could not be freed because of its close adherence to the aorta. The surface of this mass was white, interspersed with soft, depressed areas of hemorrhage. A biopsy was taken, the abdomen was closed, and the pathologic report on the tissue was Wilms' tumor (Fig. 2). From May 20 to July 1, 1944, 50 to 100 r (air) were given daily to anterior, posterior, and lateral ports for a total of 1,050 r (air) to each port. The factors were 200 kv., 10 ma., 50 cm. skin-target distance, and a Thoraeus filter, with a h.v.l. of 1.95 mm. of copper. The child was last seen in January 1951 with no evidence of disease and with a normally functioning kidney on the left as demonstrated by intravenous pyelography.

CASE IV: S. L., a white girl 7 years of age, was admitted June 27, 1944. The only complaint was

hematuria for two days prior to admission. Physical examination revealed a smooth mass in the right abdomen extending from under the costal margin down to the level of the umbilicus, thought by the examiner to be liver. The temperature was 99.6° C. The hemoglobin was 70 per cent, the red cell count 3,860,000, and the white count 5,600. Roentgen studies (Fig. 12) revealed a well defined mass in the right upper quadrant. The renal pelvis and calyces were displaced superiorly and medially and were compressed, elongated, and distorted. The right ureter was displaced medially over the spine. At operation, July 1, 1944, a tumor was found arising from the lower pole of the right kidney, measuring 13 × 11 × 9.5 cm. The mass and the kidney were removed and the pathologic diagnosis was Wilms' tumor (Fig. 7). From July 24 to Sept. 7, 1944, the patient received 100 r (air) daily to alternating anterior, posterior, and lateral ports for a total of 1,000 r (air) to each port, with the factors cited in Case III. On Jan. 14, 1951, she was alive and healthy, with no evidence of recurrence.

CASE V: M. S., a white boy 2 years of age, was admitted Aug. 1, 1944, because of an abdominal mass, frequency of urination, and irritability of four weeks duration. Examination revealed a large mass in the right side of the abdomen. The temperature was 100° C. The hemoglobin was 58 per cent, the red cell count 2,280,000, and the white count 6,400. The urine was negative. Roentgen studies (Fig. 11) revealed a hydronephrosis on the right with a normal appearing kidney outline. There appeared to be a soft-tissue mass, chiefly to the right of the midline in the lumbar region, extending across the midline and displacing the left ureter laterally. At operation, a large retroperitoneal tumor was encountered, measuring 15 × 15 × 15 cm., and, in the words of the surgeon, "attached to everything." It arose from the lower pole region, lay chiefly inferior and medial to the kidney, and extended across the midline to the left. The mass and the kidney were removed, but the child died as the abdomen was being closed. The diagnosis was Wilms' tumor (Fig. 5).

CASE VI: F. B., a white boy of 8 years, was admitted Jan. 15, 1945, because of an abdominal mass and "infected kidneys." The abdominal mass was of recent origin, but the mother stated that the child had had "infected kidneys" for about one year and that at the onset there had been marked swelling of the face, hands, and feet. Examination revealed a hard, slightly tender mass in the left side of the abdomen in the kidney region. There was no peripheral edema and the temperature was normal. The hemoglobin was 65 per cent. The red cell count was 3,410,000, and the white count 7,250, with a normal differential count. The urine was negative. The non-protein nitrogen and creatinine were within normal limits. Urograms (Fig. 14) revealed a hydronephrosis of the left kidney, which was also rotated and displaced laterally. There was no deformity of the pelvis and calyces other than that attributable to the hydronephrosis. At operation a mass was found inferior and medial to the left kidney, which was rotated and displaced laterally. Since the tumor could not be removed, a biopsy was done, and the abdomen closed. The report on the biopsy specimen was Wilms' tumor. The child received 3,000 r (air), total, to anterior, posterior, and lateral kidney ports over a period of seven weeks. He did not return for follow-up, but it was learned that he died about eight months postoperatively.

CASE VII: H. B., a white girl 8 years of age, was admitted July 14, 1948, with an abdominal mass of one month duration, associated with anorexia and weight loss. Examination revealed a large, hard, nodular mass filling the entire left side of the abdomen and moving slightly with respiration. The temperature was 100.4° C. The hemoglobin was 71 per cent, the red count 3,550,000, and the white count 10,500. The urine was negative. Urograms confirmed the presence of a large mass filling the left side of the abdomen and showed calcification in the lower portion. The pelvis and calyces of the left kidney were dilated and flattened and were displaced superiorly and medially. The abdominal contents were displaced into the right side of the abdomen (Fig. 10). In thirty treatment days a total of 4,500 r (air) was administered preoperatively to anterior, posterior, and lateral ports (factors: 200 kv., 10 ma., 50 cm. skin-target distance, and Thoraeus filter, with a h.v.l. of 1.95 mm. of copper). The size of the tumor was reduced one-third. Surgery followed immediately and the left kidney was removed along with a 12 × 12-cm. tumor arising from its lower pole. The pathologist reported a Wilms' tumor showing a marked degree of myxomatous change but with many viable tumor cells remaining and surrounded by dense connective tissue. Postoperative irradiation, amounting to 1,700 r (air), was administered to anterior and posterior ports. The patient ran a rapid downhill course and died two months following surgery, with a large right upper quadrant mass that was believed to be liver metastases.

CASE VIII: K. A. C., a white boy 1 year of age, was admitted Aug. 14, 1948, the mother having discovered a large right-upper-quadrant mass four days previously. For several days prior to the discovery of the mass there had been anorexia and weight loss. Examination revealed a smooth, firm mass in the right upper quadrant of the abdomen extending from the costal margin to the level of the umbilicus. The temperature was 100° C. The hemoglobin was 68 per cent, the red cell count 4,300,000, the white count 11,000. The urine was negative. The urogram (Fig. 15) revealed a mass which displaced the pelvis medially and slightly upward, displaced the right ureter medially, and

caused a distortion of the inferior major calyx, in addition to obliterating the right psoas shadow. At operation a well encapsulated, somewhat cystic mass, 10 cm. in diameter, was found arising from the lower pole of the right kidney, and both structures were removed. The diagnosis on the surgical specimen was Wilms' tumor (Fig. 8). Irradiation was instituted on the second postoperative day and a total of 3,400 r (air) was given through anterior and posterior ports, at 200 kv., h.v.l. 1.95 mm. copper. The daily dose was 100 r (air). The patient was discharged Sept. 26, but returned again on Dec. 19, 1948, with a recurrence of the right abdominal mass. An additional 1,800 r (air) was given to the right abdomen, but no reduction in the size of the tumor was obtained, and the child died in January 1949, approximately six months after he was first seen.

SUMMARY AND CONCLUSIONS

1. The histogenesis of Wilms' tumor is discussed. In view of the various theories, it is probably best to consider it as an embryonal neoplasm of indefinite origin.

2. Pathologically the neoplasm is found to be a mixed tumor composed of multiple tissues of mesodermal origin, usually of an embryonal character.

3. The growth of the tumor is silent and in most cases the presenting symptom is an abdominal mass, with secondary symptoms resulting from the mechanical effects of its presence.

4. The diagnosis is usually not difficult, the urogram being a valuable diagnostic adjunct, although it reflects nothing absolutely characteristic of this particular neoplasm.

5. The prognosis is poor. It is not influenced by the histologic type of the tumor nor by its size, but rather by the age of the patient, there being a much higher cure rate in patients under one year of age than in older children.

6. Recurrences usually appear within twelve to eighteen months, so that freedom from the disease after two years probably means a cure. Recurrences have been reported, however, after three and four years.

7. The treatment of choice seems to be a combination of surgery and irradiation, though a difference of opinion exists as to the sequence of the two measures.

8. Inoperable cases, in the absence of widespread metastases, should be given the benefit of intensive irradiation, as amazing cures under these circumstances have been reported.

9. Eight proved cases of Wilms' tumor are presented.

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SUMARIO

El Tumor de Wilms en la Infancia y la Niñez

Al presentar 8 casos de tumor de Wilms en niños, discútense las características patológicas y clínicas. A la luz de las varias teorías relativas a la histogenia del tumor, parece mejor considerarlo como neoplasia embrionaria de origen indefinido. Trátase de una neoplasia compuesta de tejidos múltiples de origen mesodérmico.

El crecimiento del tumor es insidioso, y en la mayor parte de los casos el signo aparente consiste en una tumefacción abdominal, con síntomas secundarios debidos a los efectos mecánicos.

El diagnóstico no suele ser difícil, constituyendo el urograma un valioso coadyuvante del mismo, aunque no refleja nada absolutamente típico de esa neoplasia dada.

El pronóstico es malo. No lo afectan ni la forma histológica del tumor ni el tamaño del mismo, sino más bien la edad del enfermo, siendo mucho mayor el índice de curaciones en los niños de menos de un año que en los mayores.

Las recurrencias suelen aparecer en término de doce a dieciocho meses, de modo que la ausencia de la enfermedad después de transcurrir dos años probablemente denota curación. Sin embargo, se han comunicado recurrencias al cabo de tres y de cuatro años.

El tratamiento de elección parece ser una combinación de cirugía y de irradiación, aunque hay discrepancia de opiniones en cuanto al orden en que deben aplicarse. Los casos inoperables, de no haber metástasis generalizadas, deben recibir el beneficio de la irradiación intensa, pues se han descrito algunas curaciones notables en esas circunstancias.

Brain Tumors in Children[1]

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Approximately one-sixth of all brain tumors occur in children under fifteen years of age. French (8), reporting from the University of Minnesota Hospitals, stated that 1 per cent of all patients admitted to the pediatric service had a brain tumor. There seemed to be a peak incidence at two years and again at six years. Stern (16) states that over one-half of the brain tumors in children occur during the first five years of life, and in Pilcher's (15) series 40 per cent of the children were seven years of age or younger. Of 427 tumors in patients under fifteen years of age, 6 were seen in infants less than a year old. Gross (9) studied 9 cases of primary brain neoplasm occurring in the first two years of life. Of our group of 34 brain tumors in patients whose ages ranged from eleven months to fifteen years, 19 were in children six years of age or younger.

Most authors agree that two-thirds of the brain tumors in children occur beneath the tentorium. The majority of these are highly malignant. In a study of four large series of cases, gliomas were found to make up 70 per cent of the total. Of 154 brain tumors in children studied by Cushing (3), there were 116 miscellaneous gliomas, 21 congenital tumors (of which the majority were suprasellar cysts), and 6 tuberculomas.

The cerebellar and fourth ventricle tumors and tumors of the pons and medulla make up the group of subtentorial tumors. Davis (5) groups the medulloblastomas, astrocytomas, and ependymomas under the term "midline cerebellar tumors."

The medulloblastomas may arise from the roof of the fourth ventricle, vermis of the cerebellum, or posterior part of the middle of the cerebellum. The astrocytomas usually arise from one cerebellar hemisphere, but may take origin in the midline above the fourth ventricle. In many cases these tumors are cystic. The ependymomas arise from the walls and floor of the fourth ventricle. The tumors of the pons and medulla are most often highly malignant, infiltrating gliomas.

Cushing stated that the astrocytoma of the cerebellum is twice as common in childhood as the medulloblastoma. French found astrocytomas nearly four times as common as medulloblastomas, but he had a large group of supratentorial tumors and included the astrocytomas in this region. Bucy and Haverfield (2) reported that 25 per cent of their subtentorial tumors were astrocytomas and 20 per cent medulloblastomas. Keith and his associates found astrocytomas and medulloblastomas of equal frequency beneath the tentorium (11). Stern, however, had 11 medulloblastomas in his series, with 6 cerebellar and 6 pontine astrocytomas.

Our subtentorial tumors included 5 astrocytomas (Fig. 1) and 7 medulloblastomas (Fig. 2), all of which arose in the cerebellum or the fourth ventricle. There were also 1 glioma, 1 hemangioma, and 2 unclassified tumors of the cerebellum, and 1 pinealoma, 2 ependymomas, and 4 unclassified tumors of the fourth ventricle. No pontine tumors were encountered.

Most supratentorial tumors in children occur in or around the third ventricle. Buchanan (1) states that tumors of the cerebral hemispheres are uncommon in children and almost unknown before the age of two years. Tumors about the third ventricle make up 20 per cent of childhood intracranial tumors, according to Bucy and Haverfield. One-fourth of these are pineal tumors, one-fourth craniopharyngiomas,

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1951.

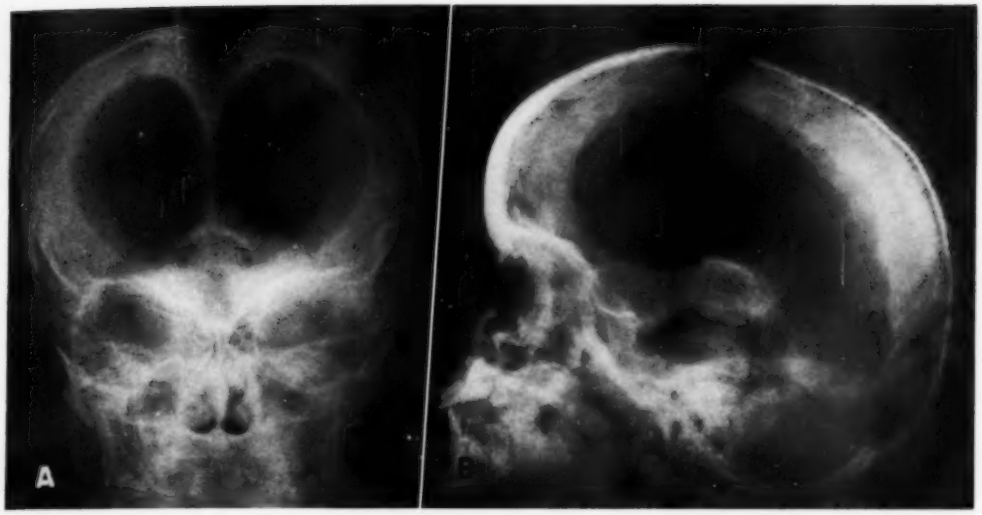

Fig. 1. L. D., white male, age 8 years. Astrocytoma of the fourth ventricle. Ventriculogram shows marked dilatation of the ventricular system.

A. Anteroposterior view showing that the dilated lateral ventricles and the third ventricle are not shifted, suggesting the possibility of a midline cerebellar lesion.

B. Lateral view. One sees here the filling defect in the floor of the fourth ventricle due to the tumor mass.

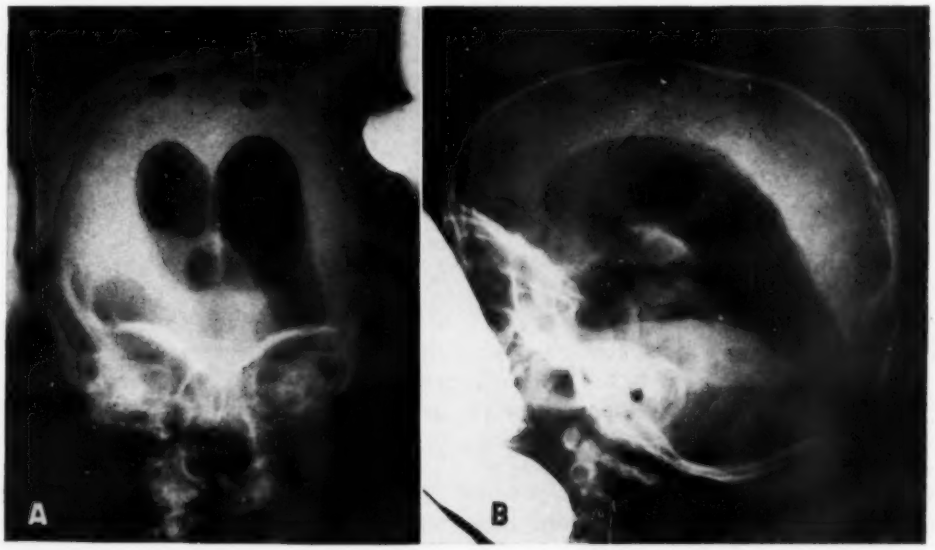

Fig. 2. M. O., white male, age 5 years. Medulloblastoma of the fourth ventricle. The ventriculogram shows a dilated ventricular system, suggesting an obstructive subtentorial lesion.

A. Both lateral ventricles and the third ventricle appear dilated, with no displacement, in the anteroposterior view.

B. In the lateral view the aqueduct and fourth ventricle are visualized and a mass is seen in the mid portion of the fourth ventricle.

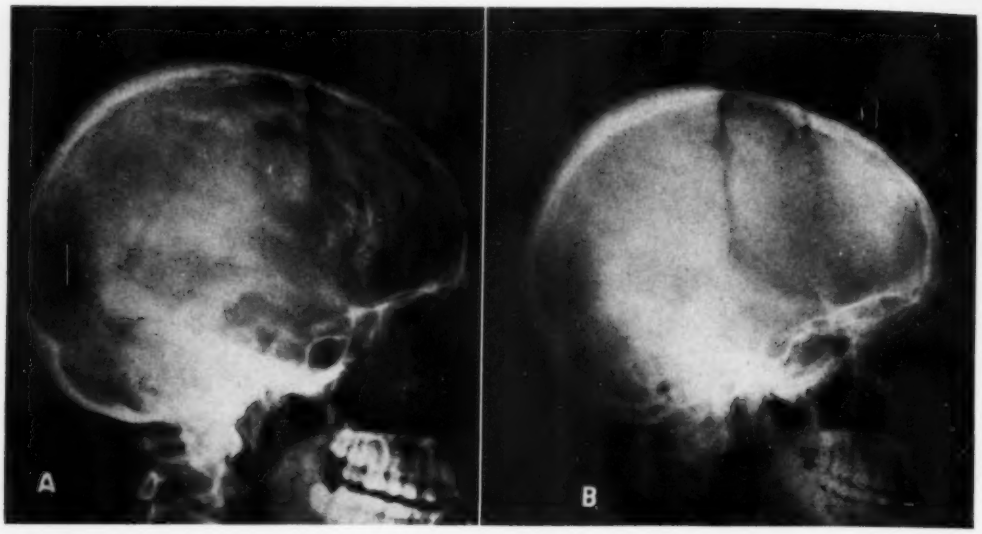

Fig. 3. B. R., white female, age 15 years. Glioblastoma multiforme with calcification, left frontal lobe. Operation followed by x-ray therapy; patient living but not completely well nine years later.
A. Preoperative film (1941), showing calcification in the tumor with evidence of increased intracranial pressure.
B. Postoperative film (1950). No evidence of calcification or increased intracranial pressure.

and the remaining 50 per cent are gliomas of the thalamus, hypothalamus, or optic chiasm. In a series of 145 supratentorial tumors in children under fifteen years of age, 16 per cent were craniopharyngiomas. Astrocytomas and glioblastomas multiforme each accounted for 12 per cent. Another 16 per cent was divided almost equally between ependymomas and pituitary adenomas, and the remaining 44 per cent was made up of other tumors.

There were 11 supratentorial tumors in our series. Of these, 5 were in the cerebrum, 2 in the frontal lobe, 1 in the temporal lobe, and 2 were not localized. Four of the 5 were astrocytomas and 1 was a glioblastoma multiforme (Fig. 3). There were 3 tumors of the third ventricle (Fig. 4) and 1 in a lateral ventricle. A glioma which began in the eye and extended into the brain, and a spongioblastoma of the optic chiasm completed the group.

Two-thirds of the tumors which give clinical signs before puberty are below the tentorium. The diagnostic triad for an intracranial tumor in a child is vomiting, unsteadiness, and a positive Macewen's sign. There may also be severe suboccipital headache with pain and tenderness to percussion in this area, and enlargement of the head. Since the sutures of a child's skull are capable of separation, papilledema is often absent until late.

The medulloblastomas are most common in males from three to six years of age. Gross quotes Cushing as stating these tumors occur three times as often in males as in females. They grow rapidly, cause increased intracranial pressure, choked disks, and enlargement of the head. They metastasize widely over the entire central nervous system. The average survival time varies from six months to five years. Treatment consists of cerebellar decompression and postoperative roentgen therapy.

Ependymomas of the fourth ventricle are one-third as common as medulloblastomas (Fig. 5). The symptoms are similar to those produced by medulloblastomas, but long remissions of both signs and symptoms may occur. These tumors take origin from walls and floor of the fourth ventricle. They are usually not malignant, but in this location are difficult to remove in their entirety, and the operative mortality

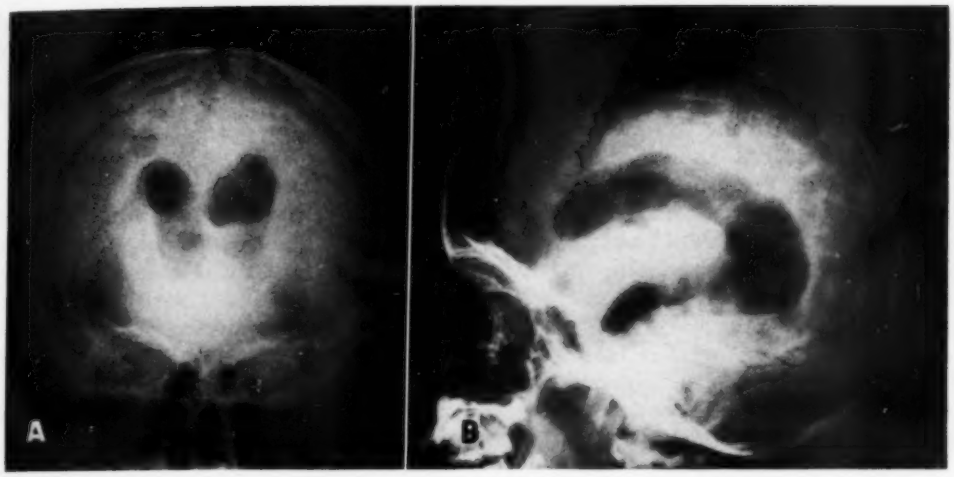

Fig. 4. B. P., white female, age 5 years. Astrocytoma of third ventricle. The ventriculogram shows dilated lateral ventricles, which are not shifted, and partial filling of the third ventricle.
A. Anteroposterior view showing the tumor mass bulging into the third ventricle from below.
B. In the lateral view the tumor is seen to arise in the region of the floor and posterior wall of the third ventricle.

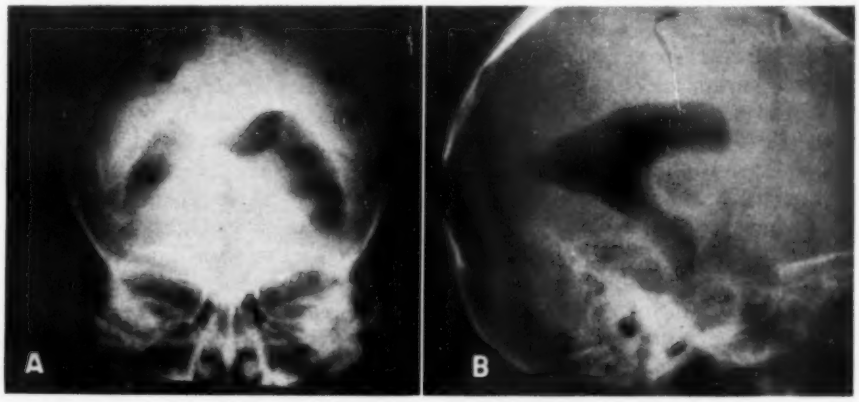

Fig. 5. H. G., white male, age 9 years. Ependymoma of fourth ventricle. The ventriculogram shows slight dilatation of the ventricles, with displacement produced by the tumor.
A. The postero-anterior view shows dilatation of the lateral ventricles, third ventricle, and aqueduct. The fourth ventricle is of normal size. The posterior part of the third ventricle is tilted upward and to the left.
B. The lateral view with the brow down shows no abnormalities of the ventricles except slight dilatation.

is very high. Response to radiation therapy is poor.

The cerebellar astrocytomas are benign, grow slowly, have a low surgical mortality, and do not recur if removed. They are usually partially cystic. They produce increased intracranial pressure with headache, vomiting, and choked disks. They are typically confined to one cerebellar hemisphere, and the signs of cerebellar dysfunction are primarily unilateral.

The tumors of the pons and medulla usually involve the pons primarily. They produce extensive defects in action of the cranial nerves and cerebellar and pyramidal systems without evidence of papilledema or increased intracranial pressure. Most of the tumors are highly malignant,

infiltrating gliomas, resistant to all forms of treatment, with a clinical course of only a few months before death. They are more common in females than males and tend to occur from six to twelve years of age. Usually marked ataxia and inco-ordination appear after defects in the action of cranial nerves become noticeable.

The tumors about the third ventricle all produce increased intracranial pressure, and treatment is generally unsatisfactory. In glioma of the optic chiasm, the most important sign is bilateral primary optic atrophy occurring in a child from two to six years of age. It may be associated with generalized neurofibromatosis.

Complete surgical removal of suprasellar cysts is rarely possible, but early operation may save sight, prolong life, and give relief for some years. Radiation therapy postoperatively has proved beneficial.

Keith (11) and his group reported that plain roentgenograms of the skull indicated the presence of a tumor in 69.5 per cent of cases. Findings include separation of sutures, erosion of the clinoids and/or the floor of the sella, abnormal areas of calcification. erosion or thinning of localized areas in the frontal, parietal, or occipital bones. Buchanan states that 70 per cent of craniopharyngiomas show suprasellar calcification. French found evidence of increased intracranial pressure in 80 per cent of plain roentgenograms of children with brain tumors. There was abnormal intracranial calcification in 20 per cent, with the astrocytomas, ependymomas, and craniopharyngiomas accounting for half this group. Ventriculograms were done on 38 patients and were of localizing value in 78 per cent.

X-ray examination was carried out in 31 of our 34 patients. In 17, plain films of the skull were obtained, and 13 of these showed signs of increased intracranial pressure. This latter group comprised 5 supratentorial tumors and 8 subtentorial tumors. Findings were negative in 4 patients, 1 with a supratentorial and 3 with subtentorial tumors.

Ventriculography was done in 16 patients. Dilated ventricles only were found in 4, all with subtentorial tumors. The diagnosis of a localized mass was made in 12 patients, of whom 3 proved to have supratentorial tumors and 9 subtentorial.

Drumheller, Keith, and Bickford (6) studied electroencephalograms of 50 children with proved neoplasm of the brain. Correct localization was obtained in 75 per cent of tumors of the cerebral cortex. Bilateral abnormalities were noted in the electroencephalogram in 70 per cent of posterior fossa tumors, but other conditions capable of producing these abnormalities must be excluded by clinical and laboratory studies. In supratentorial tumors of or near the brain stem, no localizing or consistent electroencephalographic pattern was observed.

Topper (17), studying the basal metabolism of children with tumors, found that 21 children, aged five to eighteen years, with brain tumors showed consistently low basal metabolic rates, varying from −3 per cent to −21 per cent, and slow pulse rates, ranging from 52 to 79 per minute. There was no relation between the degree of malignancy and the level of the basal metabolism rate. Sixteen children, aged five to twelve years, with highly malignant tumors in other areas than brain showed an elevated basal metabolism rate, varying from +27 per cent to +59 per cent. In 3 cases of relatively benign neurogenic chest tumors the basal metabolism was approximately normal, +9 per cent to +12 per cent.

Cutler, Sosman, and Vaughan (4), discussing the place of radiation in the treatment of cerebellar medulloblastoma, state that untreated patients usually die within one year and that operation, no matter how radical, will rarely give relief of symptoms for more than six months. Even with postoperative irradiation five-year survival is exceptional. In view of these observations Cutler and his associates refer to Béclère's proposal that radiotherapy be given without even a decompression and cite as an advantage a drop in immediate mortality from 25 to less than 2 per cent.

They themselves believe that the results are as good with radiotherapy alone as with surgery and postoperative irradiation, though their series is not sufficiently large to settle this point. In 17 of their 20 cases, operation of some type preceded irradiation, while only 2 were treated by irradiation alone. The average survival for these 2 patients was 19.5 months, and one lived, symptom-free, for 35 months. The average survival for the patients operated upon before receiving radiotherapy ranged between 13 and 14 months with "inadequate" irradiation to 30.7 months for 4 patients in whom irradiation was given to both the spine and ventricular region. Four of the patients receiving both operation and irradiation were alive after intervals of 10, 11, 46, and 58 months.

The marked improvement seen within ten days after initiating radiotherapy in cases of medulloblastoma is of diagnostic value, since other tumors in this region are not radiosensitive. No correlation was found between the degree of malignancy and duration of life, nor did the rapidity of growth of the tumor depend upon the age of the patient.

Cutler and his colleagues gave 200 r per day to the cerebellar area and 300 r to each side of the head, covering all portions of the brain and its fluid pathways. One area was treated daily until a total of 800 r was given to the cerebellar area and 600 r to each side of the head. Then 300 r per day was given to the spine until 600 r had been given to each spinal port. After six weeks the cerebellar area was retreated; two months later the entire series was repeated, three months later the cerebellar series only, and three months and six months later the entire series.

Pendergrass, Hodes, and Godfrey (14) treated 31 children with cerebellar medulloblastoma with some form of radiation therapy following operation. Their patients lived an average of twenty-eight months following operation and postoperative radiation therapy, as compared to an average postoperative survival of 3.1 months in a series of 14 patients not irradiated postoperatively. Radiation prolonged life but did not effect cures.

These authors started treatment four to six weeks after decompression. High-voltage radiation with a fractionated technic was used and a total dose of 2,000 r to each of three cerebellar, two cerebral, and two or three spinal areas was recommended. The entire course was repeated in four to six months. In some cases it was felt that perhaps larger doses should be used. More recent publications tend to confirm this (12).

In a group of 58 tumors of the brain and spinal cord in children in which roentgen therapy was used, Mandeville (13) found 13 medulloblastomas of the cerebellum. One girl was alive and well after partial removal of the tumor and five series of deep x-ray treatments. Three patients lived over four years, after which spinal cord metastases developed, although the entire cerebrospinal axis had been irradiated. In one case in which the cerebellum received a tumor dose of 5,763 r, no tumor cells were found in this region at necropsy, but the spinal cord, treated with 4,261 r, showed living neoplastic cells. Glioblastoma multiforme and pontile tumors were completely resistant to radiation.

Ingraham and Scott (10) treated 16 children with craniopharyngioma. They feel that surgery is the treatment of choice but that, if recurrence has been rapid after surgery, roentgen therapy to the tumor may be the safest and most effective method. Frazier (7) has used x-ray therapy postoperatively in hypophyseal duct tumors, with good results.

Keith, Craig, and Kernohan (11) had 34 five-year survivals in a series of 427 brain tumors in children under fifteen years of age. Thirteen of the survivors had astrocytomas, 6 craniopharyngiomas, 3 ependymomas, and 12 other assorted tumors. Eight patients were alive ten years or more, 6 with supratentorial and 2 with subtentorial tumors.

X-ray therapy was administered to 10 of our patients. Seven died and 3, aged ten, thirteen, and fifteen years, were im-

proved. The tumors in these 3 cases were, respectively, a fourth ventricle medulloblastoma, an unclassified third ventricle tumor, and a cerebral glioblastoma multiforme with extensive calcification.

The radiation was given through four 10 × 10-cm. ports covering both sides and the front and back of the head. The factors were 200 kv. constant potential, composite Thoraeus filter, 50-cm. skin-target distance. Treatments were given daily, 200 r per day. The patients who improved received a total of 6,000 r or more to the skull, measured in air, averaging 1,650 r per port. In the 7 who died the average dose per port was 1,200 r (in air) with a total to the skull of less than 5,000 r. In cases of medulloblastoma, the dose over the spine ranged from 2,500 to 2,800 r (in air) to each of two ports.

Twenty-five of the 34 children in our group were dead or unimproved at the end of a year and 9 were living and improved for more than one year. Of 11 with supratentorial tumors, 6 were dead or unimproved and 5 were improved. Of 23 with subtentorial tumors, 19 were unimproved or had died, and 4 were improved.

Four of the 7 children with cerebral tumors were improved and 3 were dead or unimproved; 2 with third ventrical tumors died and 1 was improved; the 1 patient with a tumor of the lateral ventricle died. Only 1 of the group of 12 with cerebellar tumors was improved, and only 3 of the 11 with fourth ventricle tumors.

In the astrocytoma group there were 5 who were improved, while 5 died or were unimproved. Seven of the 8 patients with medulloblastoma died and 1 was improved. Three patients with miscellaneous gliomas died or were unimproved and 1 was improved. All of those with pinealoma (2), ependymomas (2), and hemangioma (1) died. Of 7 patients with unclassified tumors, 5 were dead or unimproved and 2 improved.

The children in this group of 34 cases ranged in age from eleven months to fifteen years. In the age group from eleven months to six years there were 19 cases, 5 supratentorial and 14 subtentorial tumors. Only 2 of these 19 patients showed improvement; each was four years old. Their tumors were subtentorial, one an astrocytoma and the other unclassified.

The 15 patients in the age group from eight to fifteen years had 6 supratentorial tumors, with only 1 death; 9 had subtentorial tumors, and 7 of these died or were unimproved. Four of the 8 deaths were in children of eight and nine years.

SUMMARY

Literature covering the diagnosis, treatment, and prognosis of brain tumors in children has been reviewed. Our experience with 34 proved cases would indicate that the prognosis is worse in the younger age group, since medulloblastoma is more common in children of this age and they are poorer surgical risks. Under six years 75 per cent of the tumors were subtentorial; over six years the subtentorial tumors made up 60 per cent of the total number.

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SUMARIO

Tumores Encefálicos en los Niños

Después de repasar la literatura referente al diagnóstico, tratamiento y pronóstico de los tumores cerebrales en los niños, el A. presenta su experiencia propia en 34 casos comprobados. Esas observaciones indican que el pronóstico es peor en el grupo de menor edad, por ser el meduloblastoma más frecuente en los pequeños de esa edad y ser éstos peores riesgos quirúrgicos.

En la serie del A., la edad de los niños variaba de once meses a quince años. En el grupo etario de once meses a seis años había 19 casos: 5 de tumores supratentoriales y 14 subtentoriales. De esos 19 niños, sólo 2 mostraron mejoría; ambos tenían cuatro años, siendo en uno el tumor astrocitoma y en el otro no clasificado. Los 15 enfermos de ocho a quince años de edad tenían 6 tumores supratentoriales, con una sola muerte y 9 subtentoriales, muriendo o no mejorando 7 de este último grupo. Cuatro de las 8 muertes ocurrieron en niños de ocho y de nueve años.

A 10 enfermos se administró roentgenoterapia, muriendo 7 y mejorando 3, de diez, trece y quince años, respectivamente, de edad. En esos 3 casos, los tumores fueron, respectivamente, meduloblastoma del cuarto ventrículo, tumor no clasificado del tercer ventrículo y glioblastoma cerebral multiforme con extensa calcificación.

Lesions of the Upper Gastro-Intestinal Tract in Infants and Children[1]

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ROENTGEN EXAMINATION of the upper gastro-intestinal tract in infants and children is frequently a tedious and time-consuming procedure, but one which, with a little additional patience upon the part of the radiologist and technician, will afford gratifying results. Persistent vomiting in the newborn infant frequently imposes problems in differential diagnosis, and many times the survival of the child depends upon early recognition of the abnormality and immediate surgery. While occasionally only the routine plain films of the chest and abdomen are needed for diagnosis, the administration of contrast medium may give valuable information as to the type and location of the lesion. Seldom is there any serious contraindication to studies with appropriate contrast media. Fluoroscopy and spot-film radiography are extremely useful in the examination of these children, and in my opinion the contrast medium should always be administered under the supervision of the radiologist at the time of the examination.

The intent of this paper is to review a few of the more common, as well as some of the rare, conditions encountered in the examination of the upper gastro-intestinal tract in infants and children, with no attempt to include lesions of the colon.

ESOPHAGUS

A. Atresia: Congenital atresia of the esophagus is associated more commonly than not with an abnormal communication with the tracheobronchial tree (1). Filming the chest and abdomen of infants with apparent difficulty in swallowing at birth will frequently reveal the source of the trouble. The absence of gas in the intestinal tract indicates an obstruction in the esophagus, and increased densities in the lung fields due to aspiration pneumonitis or atelectasis may result from spill-over of the ingested contents into the respiratory tract. An opaque catheter passed into the esophagus will reveal the point of obstruction, and lipiodol injected through the catheter may demonstrate the site of communication with the tracheobronchial tree (Fig. 1).

B. Stenosis: Congenital stenosis of the esophagus may produce incomplete obstruction from birth with recurrent vomiting, and without the aid of fluoroscopy it is this type of lesion which might be readily overlooked. The constricted area is usually short, its margins are smooth, and no appreciable spasm is present (Fig. 2 A).

Acquired constrictions of the esophagus, usually due to the ingestion of lye or other caustics, present a more elongated area of narrowing, and with barium studies one may see irregular serrated margins of the involved portion due to ulceration and spasm from the resulting esophagitis. Symptoms depend upon the degree of obstruction, and frequent emergencies arise from food or foreign bodies becoming impacted at the site of the constriction (Fig. 2 B). Anastomoses from previous esophageal surgery though asymptomatic may occasionally be the site of retention of ingested food or swallowed foreign bodies (Fig. 4 A).

C. Varices: Esophageal varices in children are found almost exclusively in Banti's disease, representing collateral channels of venous drainage as a result of portal hypertension. Roentgenologically, they appear as worm-like filling defects usually confined to the lower third of the esophagus and the cardiac portion of the

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1951.

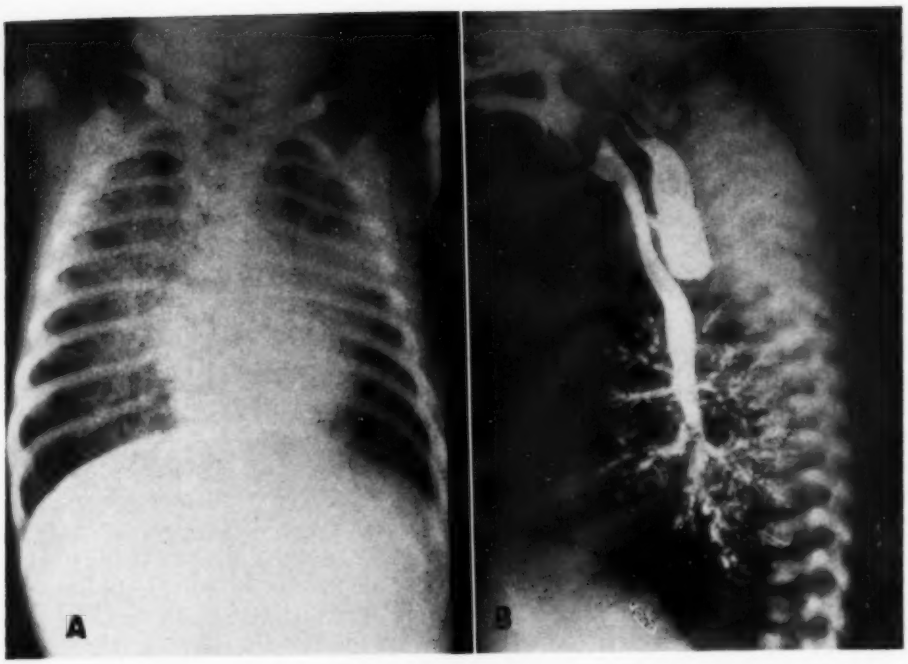

Fig. 1. A. Roentgenogram of two-day-old infant with bilateral aspiration pneumonitis as a result of esophageal atresia. Note absence of gas in intestinal tract.
B. Esophagram showing site of atresia and communication with trachea.

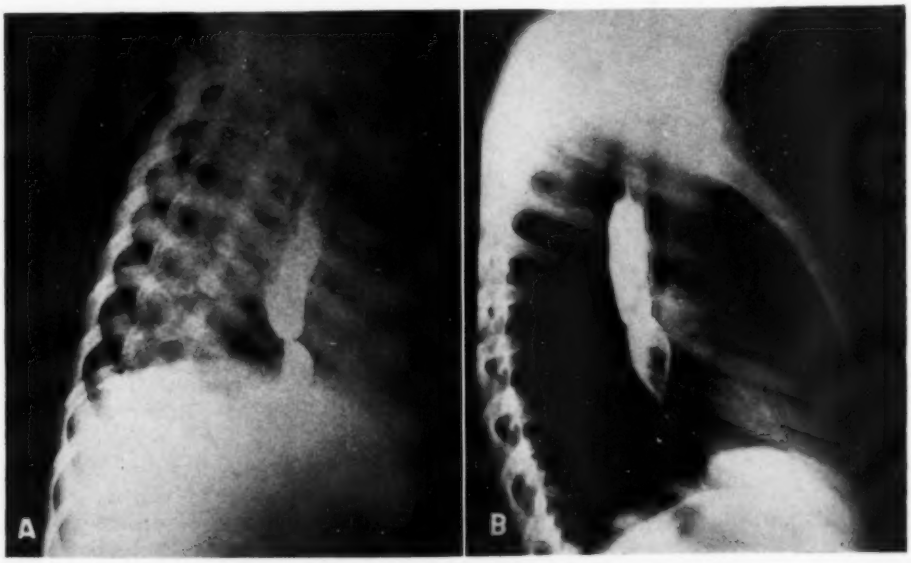

Fig. 2. A. Congenital esophageal stenosis in 15-month-old child with recurrent vomiting and inability to retain solid food from birth. Two previous gastro-intestinal studies without fluoroscopy failed to demonstrate the abnormality.
B. Acquired esophageal constriction in 6-year-old girl as a result of lye ingestion at the age of two. Note filling defect due to swallowed prune seed completely obstructing narrowed lumen.

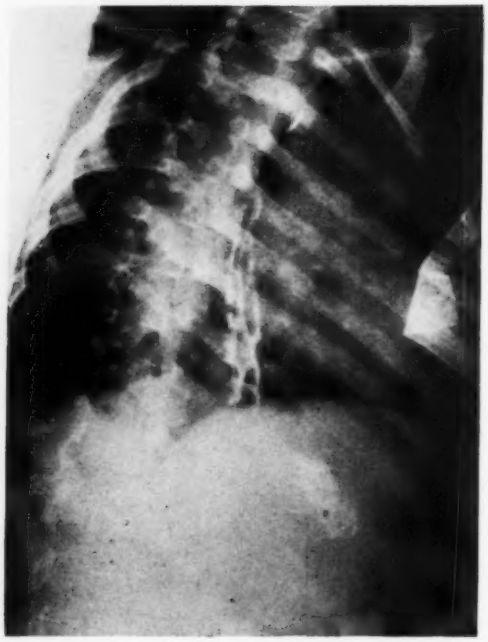

Fig. 3. Esophageal varices in child of four and a half years with Banti's disease.

stomach. They may best be demonstrated with a thin mixture of barium (Fig. 3).

STOMACH

A. Foreign bodies. (*a*) *Opaque Objects:* A common cause of alarm to parents, but frequently of little or no harm to the child, is foreign body ingestion. It is remarkable how even large and pointed objects may pass through the intestinal tract without producing serious injury to the bowel wall. Ladd and Gross (2), in a series of 337 cases, found that over 95 per cent of all foreign bodies passed through the intestinal tract without difficulty.

Some caution is necessary when straight pins, open safety pins, bobby pins, needles, and similar objects are swallowed, but again the majority of these, if allowed to remain, will pass without complication. With this in mind, it seems feasible to check the progress of the object by daily roentgenograms and then, if it appears to be lodged at any place for several days, to resort to surgical intervention. Earlier exploration may, of course, be necessary if there is clinical evidence of impending perforation or obstruction (Fig. 4 B and C).

(*b*) *Bezoars:* A different type of foreign body is that resulting from repeated ingestion of hair, thread, fibers, or other similar indigestible material, with the production of a so-called "hair-ball" or trichobezoar. On barium study these concretions present a bizarre appearance, usually quite characteristic, and may fill virtually the entire stomach (Fig. 4 D). Phytobezoars or "food balls," more common in the adult, may result from eating unripened persimmons.

B. Ulceration (*Perforation*): The infrequency of gastric and duodenal ulceration and the rarity of perforation in children are well known. The etiology of such conditions is obscure, and a definite diagnosis may not be made until surgical exploration. In each of the two cases of gastric perforation which the author has seen in infants, the roentgenogram revealed a marked pneumoperitoneum. Both children were operated upon but subsequently died. One was symptomatic at birth, though perforation did not occur until the third day. Autopsy revealed a perforated gastric ulcer which showed characteristics of chronicity, indicating that it had developed *in utero*. The second infant was asymptomatic at birth and perforation occurred on the fourth day (Fig. 5). The pathologist was reluctant in this case to state whether the inflammatory change around the site of perforation was secondary to, or the primary cause of, the rupture. There was no history of violence or trauma.

C. Infantile Hypertrophic Pyloric Stenosis: The most common lesion requiring surgical treatment during the first few months of life is hypertrophic pyloric stenosis (2). Although the diagnosis in a great many instances may be evident on physical examination, roentgen studies offer the most accurate and reliable method of diagnosis. Clinically, the condition must be differentiated from mere feeding problems, pylorospasm, other types of alimentary tract obstruction, and vomiting

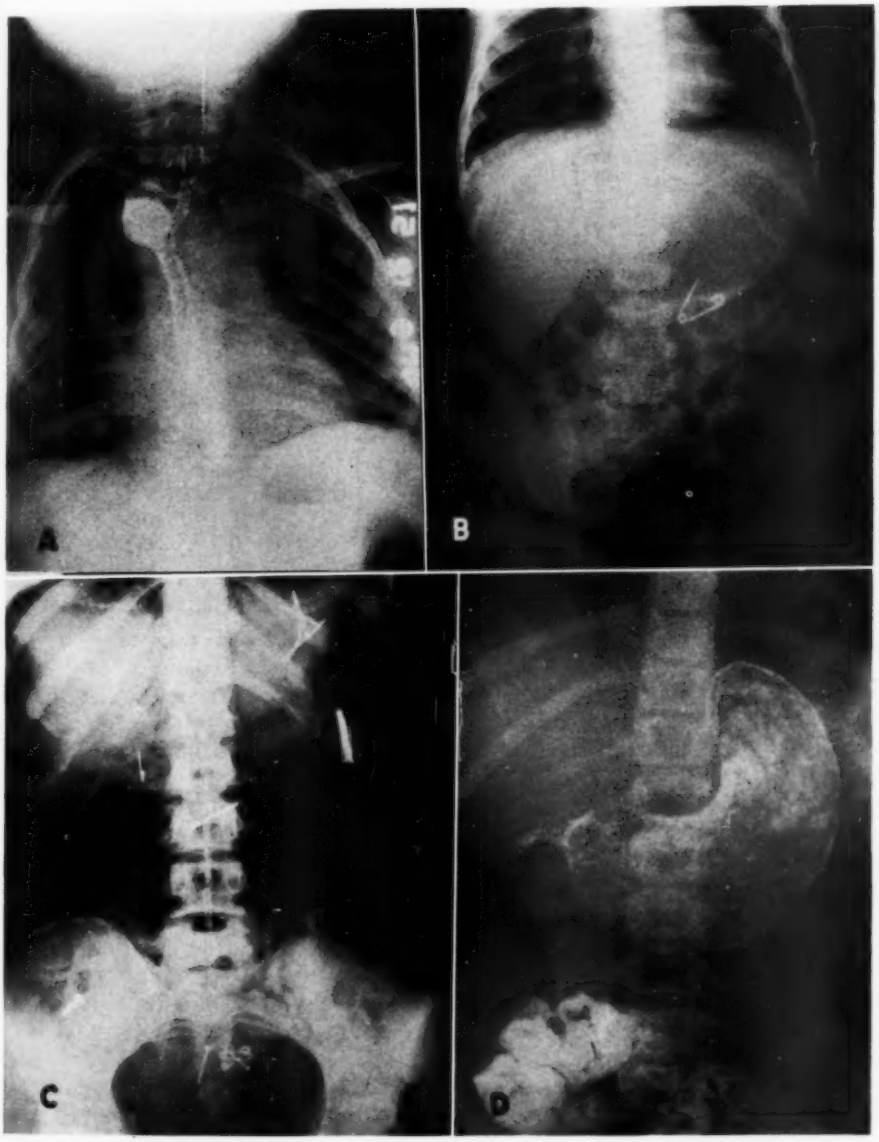

Fig. 4. A. Film of patient aged three years showing foreign body retained at site of previous surgical repair for esophageal obstruction at birth.

B. Open safety pin swallowed by seven-month-old baby. Daily roentgenograms revealed passage of the pin from the esophagus to the rectal pouch in five days.

C. Numerous foreign bodies, all of which traversed the gastro-intestinal tract without complication.

D. Large trichobezoar in stomach of eight-year-old girl who had been swallowing her own hair.

due to intracranial disease. Obstructive symptoms virtually never occur before the tenth day and usually develop between the second and tenth weeks. This is in contrast to congenital obstructions of other types. An abdominal film may show a dilated, gas-filled stomach, and barium studies reveal a slow pyloric opening time

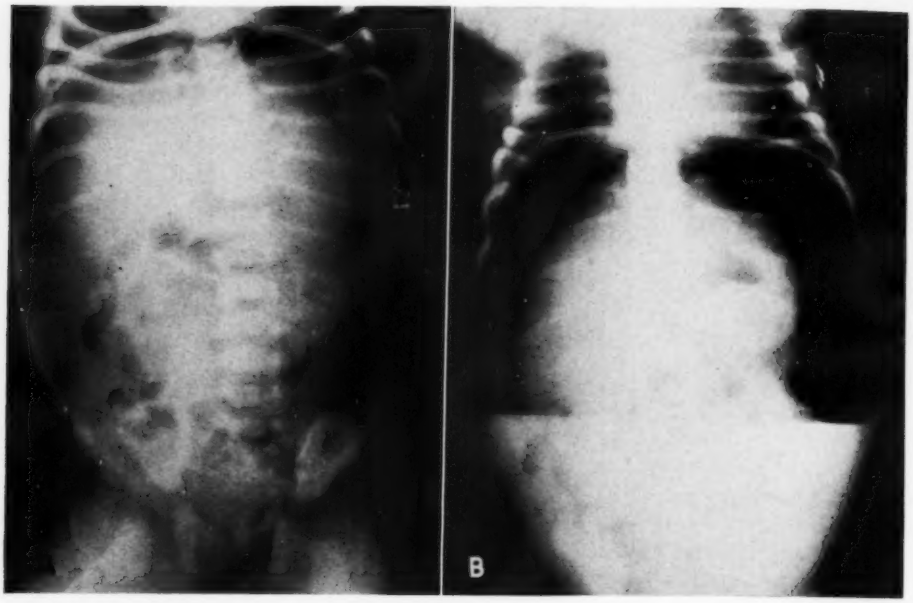

Fig. 5. Recumbent and upright films revealing marked pneumoperitoneum and fluid level as a result of perforated stomach in a four-day-old infant.

and usually delayed emptying of the stomach. The pathognomonic finding is the narrowed, elongated pyloric canal or so-called "pyloric string sign" (3) (Fig. 6 A).

D. Neoplasms: Although rare in children, new growths of the stomach are worthy of mention because of their complications and the need for surgical extirpation. Frequently they are the source of obscure bleeding from the intestinal tract and may produce serious hemorrhage as a result of central necrosis and ulceration. Benign tumors and polyps represent the majority of gastric new growths in our experience, and have been best demonstrated by means of compression spot-film radiography (Fig. 6 B).

SMALL INTESTINE

A. Duodenal Obstruction. (a) Extrinsic: Incomplete rotation of the intestine with bands of peritoneum extending from the undescended cecum across the duodenum may produce obstruction by extrinsic pressure. The onset of obstructive symptoms is usually at birth. A survey film of the abdomen may reveal a distended, gas-filled stomach and duodenum proximal to the site of the obstruction. Since in most cases, however, obstruction is not complete, there may be some gas scattered throughout the small bowel and colon. A barium enema revealing the malrotated colon will usually confirm the preoperative diagnosis. Volvulus secondary to errors in rotation of the midgut during fetal development, internal hernia, annular pancreas, mesenteric cysts, and pancreatic tumors are but a few of the reported sources of extrinsic duodenal obstruction (4).

(b) Intrinsic: Although they are two distinct entities, duodenal atresia and stenosis, from a practical standpoint, can usually be considered the same, since both are commonly symptomatic at birth, the roentgen findings are similar, and in each immediate surgical intervention is usually required for relief of the obstruction. The common radiological finding is a distended stomach and duodenum with an absence or sparsity of gas in the bowel beyond the point of obstruction. Barium studies aid in determining the degree and site of obstruction (Fig. 7).

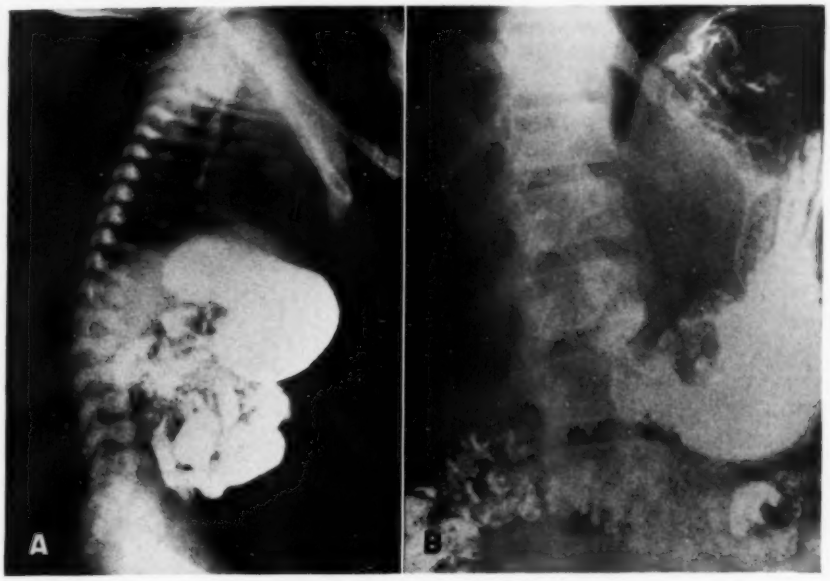

Fig. 6. A. Gastro-intestinal examination of three-week-old infant revealing pyloric narrowing and elongation characteristic of hypertrophic pyloric stenosis.
B. Leiomyoma producing smoothly marginated oval filling defect in barium-filled stomach of thirteen-year-old boy, examined because of anemia. Note barium retained within central area of ulceration.

If the stenosis is not marked, symptoms may be less severe, and several years can elapse before the difficulty is demonstrated. For example, at the time of examination of one of our infants for duodenal stenosis, its thirty-year-old mother volunteered the information that she had had a new opening made in her stomach at the age of eight because of intermittent vomiting from birth. Recently she had been having difficulty, suggesting peptic ulceration with obstructive symptoms. Barium studies revealed a poorly functioning gastro-enterostomy with a marginal jejunal ulcer and, more surprisingly, a large dilated sac representing the proximal duodenum, into which most of the opaque medium entered. This emptied only with the patient in the recumbent position and there was considerable retention in the sac at the twenty-four-hour examination (5). It was postulated that she had had a long-standing partial duodenal obstruction, relieved in part by the gastro-enterostomy at the age of eight. Additional surgery was performed, breaking down the gastro-enterostomy and substituting a duodenojejunostomy, with subsequent regression in the size of the duodenal pouch and excellent symptomatic response.

In the author's experience, stenoses have been more common in the duodenum, and atresias have occurred with greater frequency in the jejunum and ileum. Also, the survival rate of infants treated surgically for incomplete obstruction has been higher than for those with intestinal atresias.

B. Meconium Ileus: Another cause of vomiting, obstipation, and abdominal distention in the newborn infant is meconium ileus, a condition associated with pancreatic insufficiency. As pointed out by Neuhauser (6), diagnosis may be suggested by the radiographic evidence of small bowel obstruction with no abrupt termination of the visualized gas and no terminal dilated loop of bowel to suggest the point of obstruction. The most striking roentgen observation, however, is the peculiar mottled density in the abdominal film due to the presence of air bubbles scattered through-

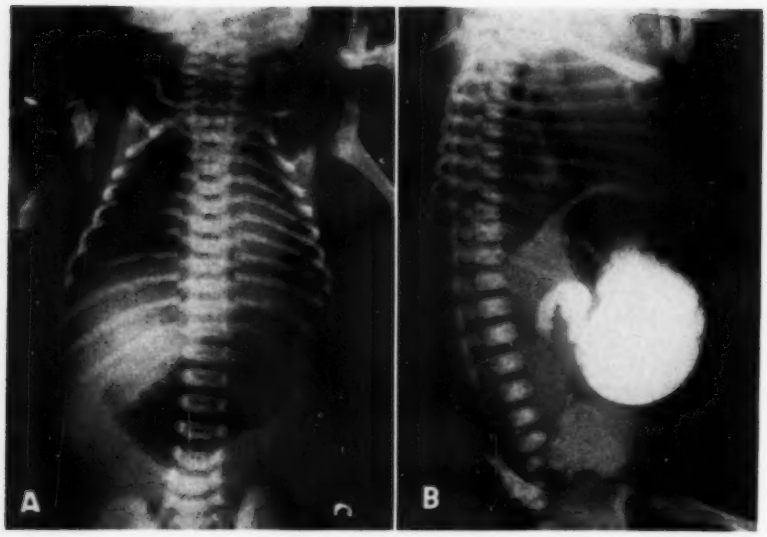

Fig. 7. A. Gas-filled stomach and proximal duodenum in two-day-old infant vomiting from birth. Note small amount of gas in intestine, indicating incomplete obstruction.
B. Barium study revealing site of duodenal stenosis. Uneventful recovery following surgery.

out the meconium-filled bowel (Fig. 8). Calcium deposits in the peritoneal cavity indicate, in addition, an accompanying perforation and meconium peritonitis (7). Of the four cases we have seen, one showed evidence of calcification. Although usually unnecessary and of no additional value, a barium enema was given in one instance, revealing a collapsed but unobstructed large bowel.

C. Intra-abdominal Hernia: Congenital defects of the peritoneum and mesentery may allow most of the small bowel to herniate into a mesenteric pouch, producing a so-called intra-abdominal or internal hernia. According to Ladd and Gross, there are seven sites through which the bowel may enter. This condition may be observed incidentally at autopsy in patients who had no apparent difficulty related to it. It may, however, be the cause of intestinal obstruction. The diagnosis, as pointed out by Golden, can be made when the barium-filled small bowel is coiled in a circular pattern and there is difficulty in separating the loops of bowel by palpation (8). Although we have encountered no instance in children, the abnormal circular course of a Miller-Abbott tube during the process of intubation of a patient with mechanical bowel obstruction was proved to be the result of a paraduo-

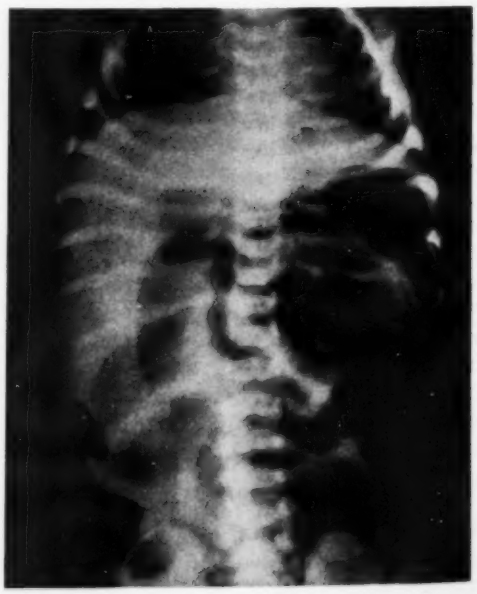

Fig. 8. Meconium ileus in patient, aged two days. Note characteristic mottling due to air bubbles within the meconium-filled ileum.

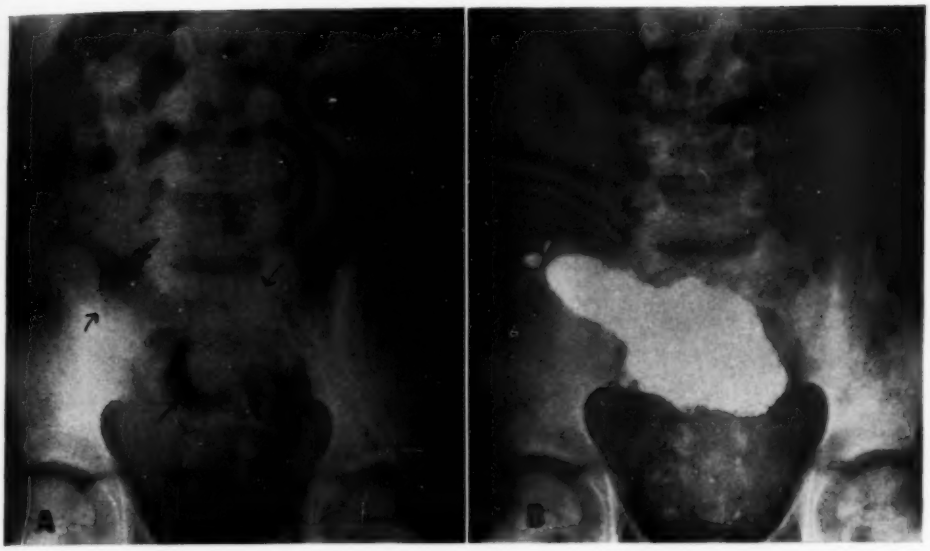

Fig. 9. A. Roentgenogram of six-year-old boy with right-lower-quadrant mass, anemia, and weight loss. Note localized segment of dilated small bowel.
B. Five-hour interval film of small intestinal study showing persistent filling of irregular, dilated, rigid segment of ileum characteristic of lymphosarcomatous infiltration. Contour identical to gas-filled segment in A.

denal type of intra-abdominal hernia (5). Thus, one may suspect this condition from the abnormal course of the Miller-Abbott tube as it proceeds through the small bowel, as well as from small intestinal studies.

D. Lymphosarcoma: Primary lymphosarcoma of the bowel is being presented not because of its relative rarity in children as well as in adults, but because of its characteristics, which are diagnostic on roentgen examination. This neoplasm is the most common type of sarcoma of the intestinal tract and its most frequent site in the small bowel is the terminal ileum. Its origin in the lymphoid structures of the submucosa accounts for the early pain frequently present as a result of the involvement of the submucosal nerve plexuses. There are usually an associated loss of weight and strength and secondary anemia. A palpable abdominal mass may be present.

A scout film of the abdomen may show a segment of dilated small bowel due to submucosal nerve plexus involvement rather than mechanical obstruction, and this may correspond to the abdominal mass if present. Small intestinal studies characteristically show an irregular, rigid, somewhat dilated segment of bowel retaining the opaque medium over a period of several hours as a result of the localized lymphosarcomatous infiltration (Fig. 9).

CONCLUSION

Ever increasing advances in surgical technic and improved care of the surgical patient place added responsibilities upon the radiologist in reducing the mortality rate of infants and children with lesions of the gastro-intestinal tract. This can best be achieved by thorough and precise roentgenologic examination.

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SUMARIO

Lesiones de la Porción Superior del Tracto Gastrointestinal en los Lactantes y los Niños Mayores

En este repaso de algunos de los estados observados en el examen de la porción superior del tubo gastrointestinal en las criaturas y niños mayores, considéranse también los hallazgos roentgenológicos.

Las lesiones esofágicas discutidas son: atresia, estenosis, tanto congénita como adquirida, y várices, que se encuentran casi exclusivamente en asociación con la enfermedad de Banti.

En el estómago, los cuerpos extraños, incluso los bezoares, exigen atención. La lesión gástrica que requiere más frecuentemente tratamiento quirúrgico en la primera infancia es la estenosis hipertrófica del píloro. Las neoplasias y las úlceras perforadas son raras.

La rotación incompleta del intestino, con franjas de peritoneo extendiéndose desde el indescendido ciego a través del duodeno, puede producir oclusión intestinal debida a la presión extrínseca. Las causas intrínsecas de oclusión comprenden atresia y estenosis; según ha observado el A., la primera es más frecuente en el yeyuno y el ileon. El íleo mecónico se presenta unido a insuficiencia pancreática. Otra causa de obstrucción es la hernia intraabdominal o interna debida a vicios congénitos de formación del peritoneo o del mesenterio.

El linfosarcoma intestinal, si bien relativamente raro, es digno de interés, debido a su típico cuadro roentgenológico: un segmento entérico irregular, rígido y algo dilatado que retiene el medio opaco durante varias horas.

Los adelantos de la técnica operatoria y los perfeccionamientos en la asistencia del enfermo quirúrgico imponen nuevas obligaciones al radiólogo en las lesiones del tracto gastrointestinal en la niñez.

Radiologic Diagnosis of Respiratory Lesions in Children[1]

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THE FIRST PROBLEM that presents itself in the radiologic diagnosis of respiratory lesions in children is the securing of adequate roentgenograms from the technical standpoint (11). To obtain satisfactory negatives of the chest of a sick infant who cannot or will not lend any co-operation taxes the available equipment and the ingenuity of the technicians to the utmost.

For solving this problem for us, credit should first go to the remarkable capabilities of our technicians. They have worked out four sets of technics for all their radiographic work on children, separating the sick children from the well or recuperating and the co-operative from the unco-operative. Success depends on the technician's ability to judge and handle the patients.

Mechanically our equipment is not unusual. We have, however, found the adjunct of an impulse-timer of great advantage. This allows negatives to be made up to 1/120 of a second, which is usually sufficient to "freeze" even the most active infant.

While satisfactory negatives will greatly reduce the problem of interpretation, it remains one of great complexity. In the first place, we are dealing with respiratory structures that are undergoing formative changes (11, 12). There is still controversy as to whether certain degrees of increase in vascular, bronchial, and hilar shadows are to be interpreted as normal or in the realm of pathology (7). But even when unquestionably pathologic shadows are seen, we find that the majority do not fall in the textbook classification of "typical," and in order to justify any interpretation at all, we must put aside etiologic entities and go back to the basic pathologic and physiologic changes which we can recognize. These include infiltration, consolidation, cavitation, vascular congestion, emphysema, and atelectasis. This basis, I believe, should be re-emphasized in considering the interpretation of any radiograph, namely, that we do not see the disease on the negatives, we merely see shadows increased or decreased as a result of these basic changes.

The respiratory tract includes the nose, paranasal sinuses, pharynx, larynx, trachea, and the bronchial tree, as well as the peripheral structures of the lung and the mediastinum. This paper will be limited to lower respiratory tract conditions, which are classified under five main headings: (1) normal physiologic and growth changes, (2) congenital anomalies, (3) foreign bodies, (4) infectious diseases, and (5) neoplasms. By dividing and subdividing these groups any amount of subject material could be included. We shall consider, however, only a few examples of lesions which are relatively common in our practice, typifying the problem of differential diagnosis, and several which are of sufficient interest to warrant a brief discussion.

One has only to review the efforts of such men as Wasson (11, 12) and Caffey (1) to identify the various respiratory structures, and to establish some criteria for differential diagnosis of the changes involving these, to appreciate the complexity of the problem of interpreting physiologic and growth changes.

Concerning one phase of this work—namely, evaluation of the widened superior mediastinal shadow—I would like to comment. We have an opportunity to obtain chest negatives of a large number of infants both with and without respiratory symptoms, and it is unusual for us to see such a shadow caused by tuberculous adenopathy (2). We frequently report

[1] Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1951.

an enlarged or persistent thymus and almost as frequently follow the diagnosis with roentgen therapy. For the most part, we obtain relief of symptoms and regression of the shadow. I will, however, be the first to admit that all too frequently the report of abnormal thymus is made in the quite by accident during routine chest examination. The roentgenogram will show an absence of aeration in the affected part with a shift of the adjacent structures to fill the vacant space. The differential diagnosis lies between agenesis, massive atelectasis from any cause, and congenital

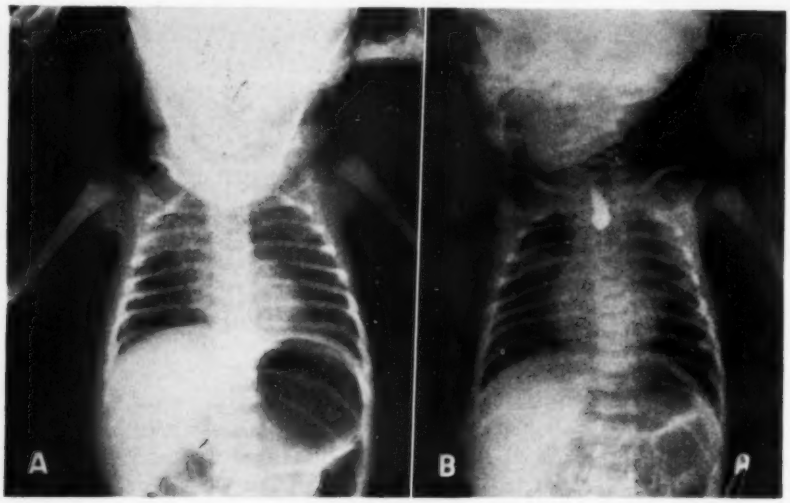

Fig. 1. A. Atelectasis and pneumonic reaction in right upper lobe undoubtedly secondary to aspiration of food. From this negative alone, the etiology would be inconclusive. B. Lipiodol in the blind upper end of the esophagus demonstrates the presence of atresia. At surgery, the lower esophagus was found to communicate with the trachea at its bifurcation, accounting for the air in the stomach and intestines.

complete absence of symptoms, and I agree wholeheartedly with Neuhauser (3) that this is unfortunate and creates needless alarm for all concerned.

CONGENITAL ANOMALIES

Of the congenital anomalies of clinical significance, perhaps the tracheo-bronchoesophageal variations with atresias and fistulae are the most phenomenal (Fig. 1). They usually present little difficulty in diagnosis or in roentgenologic confirmation. Frequently the air pattern seen on the flat films of the chest and abdomen will suffice, or lipiodol instillation will give definite visualization of the lesion.

Undoubtedly less frequent, but none the less striking, is agenesis of a lobe or an entire lung (Fig. 2). This condition may be asymptomatic and may be discovered absence of the diaphragm. Bronchographic and bronchoscopic examination are confirmatory. Agenesis is frequently associated with other anatomical anomalies, especially hemivertebrae.

FOREIGN BODIES

Foreign bodies in the respiratory tract represent a frequent cause for x-ray examination. For academic purposes it may be well to attempt differentiation of the changes incident to foreign bodies from other pathologic conditions, and it may be necessary to do so, but in our experience such patients seldom enter the x-ray department without some history to give us a lead and it would be folly to waste time on differential points in the face of a concurrent history.

Opaque foreign bodies are usually identi-

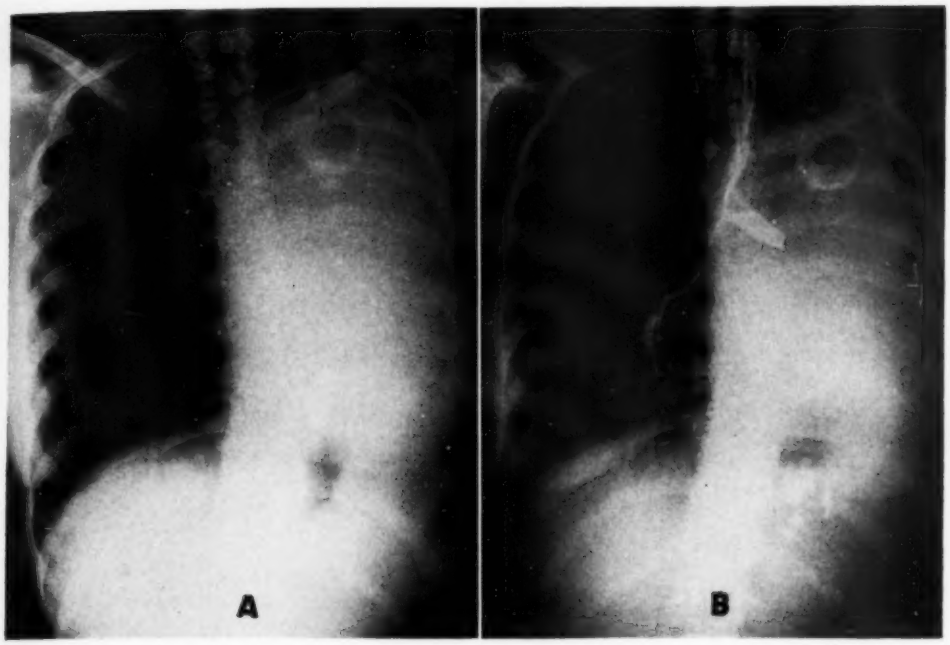

Fig. 2. A. Agenesis of the entire left lung. The heart and mediastinum have shifted completely into the left side.
B. Bronchogram demonstrating the rudimentary left main bronchus. The patient was examined because of an osteochondroma at the anterior end of the left first rib.

fied easily, but it is wise to examine the patient in several projections before passing judgment. There are too many normally opaque structures behind which small objects can hide. The findings with *non-opaque foreign bodies* are a source of greater confusion. The classical example is the course of events following a ball-valve type of bronchial obstruction. The action begins with the affected lobe or lung becoming over-aerated in appearance because of the obstruction. This hyperaeration may reach a degree sufficient to cause some mediastinal shift to the opposite side. When enough local reaction to the foreign body has occurred and the edema and secretions are sufficient to cause complete obstruction, the trapped air is gradually absorbed. The involved portion of lung then collapses and obstructive atelectasis is seen, with a shift of the adjacent structures to the affected side.

It should not be forgotten that a foreign body may lodge at the bifurcation of the trachea and the changes may occur bilaterally without any shift of the mediastinum. As a rule, however, in cases in which obstruction is suspected, inspiration and expiration films as well as fluoroscopic observation are invaluable. In obstructive emphysema, the mediastinal structures will swing toward the affected side during inspiration, while in compensatory emphysema they will swing away from the inflated side (1). In any event, the degree of involvement will depend upon the location of the foreign body in the ramification of the bronchial tree.

Another type of foreign-body reaction which we frequently encounter in our practice is illustrated by the little patient who has been imbibing and subsequently inhaling some irritant liquid such as kerosene. Aside from the irritant effects, with excessive secretions and inflammatory edema which may cause bronchial or bronchiolar obstruction in scattered areas of each lung, we have the added finding of a diffuse

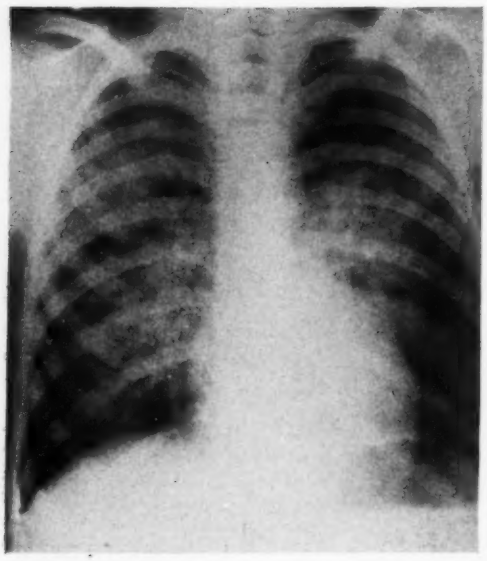

Fig. 3. Interstitial type of pneumonia resulting from inhalation of chlorine gas.

pneumonic process which is interstitial in type and is roentgenographically indistinguishable from interstitial pneumonia on an infectious basis. In fact, superimposed infection is so common that to make a differential diagnosis is useless.

Similar findings may be seen following inhalation of an irritant gas (Fig. 3). Into this same group would fall the so-called lipoid pneumonias (6) due to the inhalation of oils, as in milk, oil-based nose drops and sprays, and following bronchography.

INFECTIOUS PROCESSES

The clinician is most interested in an etiologic classification and diagnosis of the pneumonias. Roentgenographically, we would do better to consider them from the point of view of the type of tissue affected and the pathologic progression.

With the alveolar type of pneumonia, there are an exudative process in the alveolar air sacs and an excessive accumulation of secretions in the lumen of the bronchioles. The bronchi and interstitial tissues are not affected. The exudate, which replaces air, casts a shadow on the x-ray negative. The area of involvement may be localized or may include a lobe or even an entire lung. It may be bilateral. When a major portion of a lobe or an entire lobe is involved, we speak of the condition as lobar pneumonia. Radiographically the involvement is patchy or diffuse, depending on the stage. It is usually well delineated by lobular or segmental divisions of the

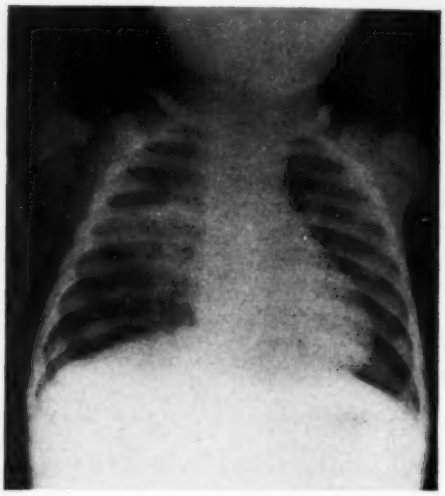

Fig. 4. Primary tuberculous pneumonia, alveolar type, in the right middle lobe. The roentgen interpretation is complicated by the hematogenous miliary dissemination throughout both lung fields.

lung and it is necessary to have lateral as well as conventional postero-anterior negatives to identify its location. From the beginning, the process is peripheral, progressing medially and to the regional lymph nodes. Although primary alveolar pneumonia in children is still most commonly caused by pneumococci, there is nothing pathognomonic about the shadows on the roentgenogram to distinguish the condition from exudative tuberculosis, infection due to any other bacterial invader, or focal atelectasis (Fig. 4).

In interstitial pneumonia, the bronchi and supporting tissues of the lung, rather than the alveoli, become involved in marked inflammatory changes. There is relatively little peripheral alveolar exudation, and consequently obstructive emphysema and atelectasis are frequent find-

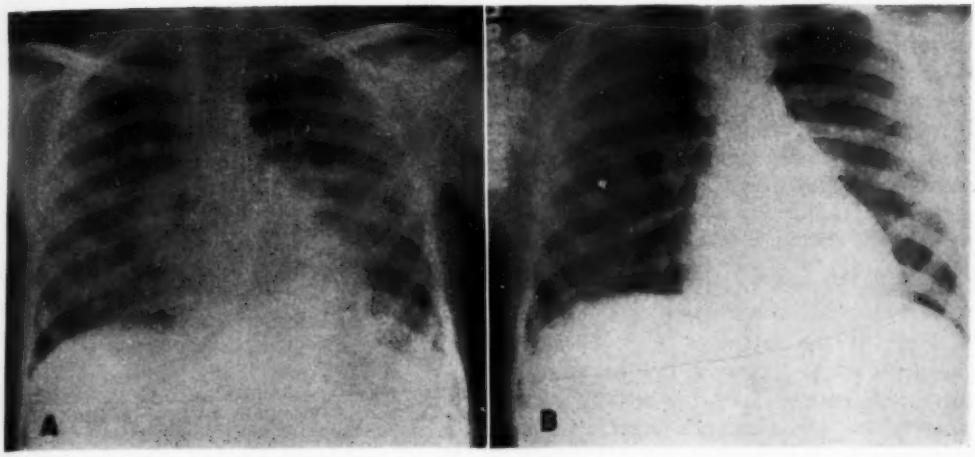

Fig. 5. A. Overwhelming disseminated miliary infection indistinguishable from hematogenous spread of tuberculosis. Proved histoplasmosis.
B. The same patient nine months later. Resolution of the process, with only a few discrete residual calcifications.

ings (10). The disease is characteristically bilateral but may involve one lung or a lobe. The roentgenogram reveals an exaggeration of the bronchovascular markings, which are surrounded by patchy areas of increased density, representing peribronchial infiltration, atelectasis, regional lymphadenitis, and lymphadenopathy (Fig. 5). Coalescence of smaller areas of increased density may produce a shadow resembling alveolar pneumonia. Massive atelectasis may be a complication and the appearance is identical with that due to any bronchial obstruction.

The interstitial type of pneumonia is most often caused by irritant inhalants, bacterial infection, viruses, and fungi, and is a frequent complication of pertussis, measles, and influenza. Occasionally, both the alveolar and interstitial types of pneumonia may be found simultaneously, producing a so-called mixed pneumonia. The complications in differentiation under these circumstances are obvious.

Bronchiectasis and pulmonary fibrosis are undesirable sequelae of the pneumonias. Pulmonary necrosis may follow, usually taking the course of a solitary abscess. Abscesses may also result from hematogenous dissemination, and are then more likely to be multiple.

Pulmonary abscesses are necrotic cores surrounded by inflammatory consolidation, casting dense shadows. Early they are indistinguishable from ordinary consolidations, but eventually the necrotic center may become less dense. If there is a communication with a bronchus, a fluid level or air pocket can be recognized.

If we have the opportunity to see repeated films on individual patients, we may visualize the course which a pathologic process is assuming and can more accurately arrive at an etiologic diagnosis. In the practical, everyday practice of radiology, however, we must often dispense with numerous examinations and give as intelligent an interpretation as we can.

NEOPLASMS

Primary neoplasms in the lungs of children are rare except for the lymphoma group with mediastinal involvement and secondary effects on the pulmonary system. Of the pulmonary neoplasms, the metastatic lesions are by far the most prominent. Of these, metastases from Wilms' tumor of the kidney, neuroblastoma, and the

osteogenic sarcoma group constitute the majority. They are usually multiple but may be solitary, and they range in size from discrete small lesions to masses involving an entire lobe or even an entire lung. The major point differentiating a neoplasm from a pneumonic process as seen roentgenographically is the absence of any associated obstructive atelectasis or emphysema (1).

SUMMARY

Some of the technical and diagnostic problems of pediatric radiologic practice have been reviewed. A few specific conditions which are of enough interest to warrant review have been presented together with examples to illustrate the problems of differential diagnosis. It is concluded that in the diagnosis of respiratory diseases in children, especially pulmonary entities, the radiologist must classify the lesions anatomically and pathologically and tread lightly where etiologic diagnosis is concerned until he has follow-up studies and the collaboration of other diagnostic departments.

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SUMARIO

El Diagnóstico Radiológico de las Lesiones del Aparato Respiratorio en los Niños

Este estudio versa sobre los problemas técnicos y diagnósticos planteados por las lesiones de la porción inferior del aparato respiratorio.

Las lesiones congénitas comprenden atresias y fístulas tráqueo-bronco-esofágicas y agenesia pulmonar.

Los cuerpos extraños se reconocen fácilmente, si son opacos. Si no lo son, es más difícil reconocerlos, máxime si provocan oclusión en forma de válvula de flotador. En la ingestión o inhalación de un aceite o gas irritante, se sobrepone al efecto irritante, producido por excesiva secreción y edema inflamatorio con posible oclusión bronquial or bronquiolar, un proceso neumónico difuso indiferenciable de una neumonía intersticial crónica.

Las neumonías de los niños pueden tomar forma alveolar o intersticial, e ir a su vez seguidas de bronquiectasia y fibrosis pulmonar. También se presentan abscesos pulmonares.

Las neoplasias son, en su mayor parte, metastáticas. Un punto de primera fuerza para diferenciarlas de la neumonía es la ausencia de atelectasia y enfisema obstructores.

Dedúcese que, en el diagnóstico de las afecciones del aparato respiratorio, en los niños, el radiólogo debe clasificar las lesiones anatómica y patológicamente. Para el diagnóstico etiológico, tendrá por lo general que atenerse a estudios consecutivos y a la colaboración con otros departmentos de diagnóstico.

DISCUSSION

(Papers by Walker; Benzing; Smith; Lockard; Chapman)

Paul C. Hodges, M. D. (Chicago, Ill.): Dr. Walker's lantern slides of osteoid osteoma were excellent. Even the small lesions in the vertebrae showed well. I agree that such lesions should be biopsied and, if proved to be osteoid osteoma, should be removed surgically. Unlike Dr. Walker, we do not follow surgery with irradiation—first, because we consider it unnecessary; second, because we are extremely reluctant to irradiate the bones of growing children.

Fibrous dysplasia is a term much used nowadays, but it should not serve the purpose of a waste basket. One of Dr. Walker's slides showed a small lesion in the shaft of the tibia which he termed fibrous dysplasia. We follow the teaching of Howard Hatcher and call such lesions "benign fibrosing lesions of the metaphysis." They require no treatment, heal spontaneously, and presumably represent manifestations in the diaphysis of the condition that is called "subchondral necrosis" when it occurs in the epiphysis.

Now as to the eosinophilic granulomas. Some xanthomas have little or no resemblance to eosinophilic granulomas and some eosinophilic granulomas appear to be quite unlike xanthomas. Frequently, however, these two conditions shade into each other, leading many workers to believe that they are actually different manifestations of a single entity. Straightforward xanthoma responds well to irradiation, of course, but in straightforward eosinophilic granuloma our group prefers surgery.

I enjoyed the papers of the other young men, but some of their terminology gave me a sense of guilt for the generation of radiologists that preceded them, the generation to which I belong and the generation from which they have learned. We have handed on to our younger colleagues many things that are good, but some of the terminology we have taught them is as outmoded as the beards and swallow-tail coats that were commonly worn by physicians fifty years ago.

In the early days of radiology we taught ourselves and were constantly being reminded by others that we could not "see" tissues but merely their "shadows," and accordingly we built up a jargon about increased densities, decreased densities, filling defects, barium swallows, gastric studies, etc., believing that only in this way could we be truly objective.

If such cautious language once had real justification, certainly that time has long since passed. We "see" by virtue of our fluoroscopic screens and films no less literally than the pathologist "sees" by virtue of a tiny inverted image produced on his retina by the light from his microscopic eyepiece.

Let us discard jargon and speak as physicians. Let us speak of tissues and organs, falling back on the older terminology of our specialty only in those cases where we are frankly unable to translate alterations in density into medical terms.

Harvey White, M.D. (Chicago): I will confine most of my remarks to Wilms' Tumor by Dr. Benzing. He has presented some very interesting cases from his own experience and in addition has covered the subject rather thoroughly. This is rather a timely subject, as malignant tumors in children are today the third cause of death, and approximately 20 per cent of the tumors are Wilms' tumors.

Much has been written about Wilms' tumor, but Dr. Benzing brings out one very important fact, namely, that in the last ten years the prognosis appears to have improved tremendously. Particularly striking are the figures of Gross and Neuhauser, who reported a probable survival rate of approximately 80 per cent in children under the age of twelve months for the period 1940–47. This change is so marked that it must be real and not merely statistical. We have reviewed our own cases at the Children's Memorial Hospital, some 40 cases in the last twenty years, and our prognosis is miserable, even considering the last ten years.

It is rather unfortunate that, as Dr. Benzing has shown, dosage figures among radiologists are not uniform and that there is considerable argument as to whether preoperative irradiation should be given. There is, however, general agreement on postoperative therapy, and it is our own feeling that immediate surgery followed by radical x-ray therapy is the treatment of choice. It is good to be reminded that even inoperable cases are not always hopeless and should have a trial of x-ray therapy, and also that x-ray therapy alone can sometimes result in cure.

John D. Camp, M.D. (Los Angeles, Calif.): Dr. Smith's figures emphasize what we all well know, that a brain tumor at any age, but particularly in childhood, is a serious lesion. The diagnosis of its presence imposes a greater responsibility on the radiologist than a similar lesion in an adult, because a child cannot interpret signs and symptoms that an adult might readily describe. Also, in childhood we not only have the problem of identifying the usual radiologic signs of brain tumor but we may be confronted with other lesions such as degenerative disease, various developmental anomalies, and angiomatous malformations.

It is interesting that in children tumors of the brain reveal a high incidence of calcification roent-

genographically. Craniopharyngioma, which occurs most frequently in childhood, exhibits calcifications in 56 to 70 per cent of cases. Ependymomas, which are most common below the age of twenty-five, exhibit calcification in my experience in 29 per cent of cases. If the analysis is confined to the supratentorial ependymomas, the incidence of calcification is 45 per cent. Pinealomas, too, exhibit a high incidence of calcification. It was observed in 50 per cent of the pinealomas reported by Love and Baggenstoss.

Because the majority of brain tumors in children are infratentorial, their early diagnosis will continue to present a roentgen diagnostic problem until, as Dr. Smith has said, a better or more practical technic for angiography in that area has been established.

I am glad to see that Dr. Smith and his associates use large amounts of air for pneumographic studies. I have always felt that one should use sufficient air to outline adequately the ventricles and subarachnoid spaces. Small amounts of air will frequently give an erroneous impression concerning the site of a suspected obstruction.

Martin H. Wittenborg, M.D. (Boston, Mass.): In pinch-hitting for my chief, Dr. Neuhauser, I will not guarantee to say the same thing he might, and I am sure I will not say it as well.

We agree wholly with Dr. Lockard that if the diagnosis of an intestinal problem cannot be made after the careful study of plain films there is usually no contraindication to using a contrast medium.

Regarding infantile vomiting, we find it more rewarding to study the lower esophagus than the stomach. Many of the lesions that are called esophageal stenosis turn out to be esophagitis associated with cardio-esophageal relaxation, with or without a hiatus hernia.

Our experience with foreign bodies is similar to that of Dr. Lockard. We follow these foreign bodies through the gastro-intestinal tract. In our experience the most common foreign body that gives us difficulty is the bobby pin which hangs up at the ligament of Treitz.

Leo G. Rigler, M.D. (Minneapolis, Minn.): I am going to discuss Dr. Chapman's paper since he undertook the rather heroic task of trying to classify respiratory diseases in children. It seemed to me that he succeeded rather admirably, but any discussant must look for points that he can criticize or argue about to make the discussion of some value, and I did find three points that I could criticize.

Unfortunately for me, Dr. Hodges preceded me and discussed my first point; namely, as to how far one should go in etiological diagnosis, and he said it so much better than I could that I will not add more except to emphasize again that all etiologic diagnoses are probabilities. That holds for bacteriologists, pathologists, and everyone else who is concerned; one has simply to decide in his own mind how good the probability is, in any particular disease, that the roentgen findings will be characteristic, to know how far he can go in making an etiologic diagnosis. I agree with Dr. Hodges that we often exercise too much caution in this direction.

Another point relates to Dr. Chapman's report concerning the enlarged thymus, which presents a dilemma if one is reluctant to overlook what appears to be, if not an abnormal thymus, certainly one out of the ordinary run, and yet we fear to place too much emphasis upon it. We resolve that dilemma by using our clinical authority to say there is an enlargement of the thymus but that it probably has no clinical significance. This, then, sets the clinician off on a search for something else to account for the symptoms or it resolves any doubts in his mind.

The third point I would criticize likewise has to do with terminology, and that is the use which Dr. Chapman made—and which I find very many radiologists make—of the term "ball-valve type of obstruction" in connection with the obstructive emphysema which occurs in an affected lobe or lung from a foreign body. This is not a ball-valve; it is a check-valve.

The only reason I emphasize it is because the mechanism involved here is so important in any consideration of the pathology of the respiratory tract. In children, particularly, emphysema and atelectasis may have many etiologies, but the mechanism by which they are produced in the case of foreign bodies in the large bronchi is the same for many other causes. The effect produced does not hinge on the fact that the foreign body is being propelled from a large lumen to one of smaller diameter; such a mechanism would produce an inspiratory obstruction and therefore an atelectasis. Rather it depends upon the change in the diameter of the bronchus which permits the foreign body to lie loosely in the bronchus during inspiration while obstructing the egress of air during expiration so that there is produced a relative expiratory obstruction and emphysema. The same thing occurs in bronchial asthma, in which mucus accumulates and produces obstructive emphysema and then may increase in amount to completely fill the bronchus and thus produce complete obstruction and atelectasis. The same mechanism may be an extremely important factor in pneumonias in the first year of life.

I have a few slides in my pocket and I would like to show one or two to illustrate another mechanism that I think is important in this connection. This other mechanism relates itself to the matter of the shunting of the circulation which occurs under such circumstances.[1]

[1] Slides shown at this point.

In this one slide are shown two films of the same patient, taken in inspiration and expiration. The inspiratory phase exhibits both lungs as normal, symmetrical, and equal in radiability. The expiratory phase shows greatly increased density of the left lung and shift of the mediastinum to the left. The right middle and lower lobes retain their inspiratory radiability while in the expiratory phase, but the right upper lobe is greatly increased in density; in fact, it could easily be mistaken for lobar pneumonia. If one were to observe only the expiratory film, it would appear that the pathologic process is in the right upper lobe and perhaps in the left lung. There is actually an obstructive emphysema of the right middle and lower lobes from a foreign body in the right stem bronchus. The density of the remaining normal lobes, right upper and all of left, is far beyond the normal expiratory density. This is the result of a shunting of the circulation into these lobes because of the obstruction produced by the emphysema of the right middle and lower lobes. The effects of such shunting must always be considered in the analysis of films in which emphysema is present.

Dr. Chapman inferred, although he did not say quite that, that the diagnosis of foreign bodies in the bronchi was a relatively simple affair, especially if you knew the history. The fact is that it is not so easy in some of the complicated cases that we see, especially those in which there is more than one foreign body.

The roentgenograms of a case in which there was no history of a foreign body that we could be sure of, as is often the case in young infants, but in which the clinical story suggests that as a possibility, will illustrate my point. The film in expiration reveals the classical picture of expiratory obstructive emphysema of the whole right lung, except for a segmental area of increased density at the base. Such a finding should suggest that there are two foreign bodies here rather than one; one had gone into a small bronchus and formed a complete obstruction with resultant atelectasis; the other remained in the main bronchus on the right side and produced obstructive emphysema of the remaining lung. There are many variants of multiple foreign bodies, so our responsibility here is a considerable one, particularly as to how intensively to pursue the search for one or more fragments of a foreign body. In cases that I have encountered, the failure to locate the second fragment has resulted rather disastrously.

March Fracture of the Tibia[1]

COL. PAUL O. WELLS, M.C.

Letterman Army Hospital, San Francisco, Calif.

SEVERAL REPORTS have been published on "march" fracture of the tibia (3, 7, 8, 12, 14, 15, 16), but dealing usually with isolated cases or small series. The same type of fracture of the metatarsals has been discussed in numerous publications (1, 4, 5, 6, 9, 10, 11, 13, 17), especially during World War II, with several large series of cases being presented.

Having failed initially to recognize the first case of march fracture of the tibia encountered, and having seen 14 additional cases in a relatively short period of time, the author considered it appropriate again to call attention to this lesion, which is seldom seen in civilian life but is found with considerable frequency at any Army camp where a large number of recruits are undergoing strenuous military training.

The tibia is second only to the metatarsals as the most common site of occurrence of this type of fracture. Krause (12), in reporting 4 cases observed among soldiers in active training, states that the most common location of the fracture is on the medial aspect of the diaphysis at the junction of the middle and upper third. Brandt (3), discussing this type of fracture in the German Army, reports that it usually occurs in the middle third of the tibia, and mostly in infantry recruits. He attributes it to the upward swing of the leg with outstretched knee and recurving of the supporting leg during rigid marching.

Roberts and Vogt (16) reported 12 cases of "pseudofracture" of the upper third of the tibia, without a history of trauma, in children ranging from four to sixteen years of age. The age range of 14 cases of "fatigue fracture" reported by Hartley (8) was similar, with practically all of the patients being children or young adults. Three of this group had bilateral fractures of the tibia.

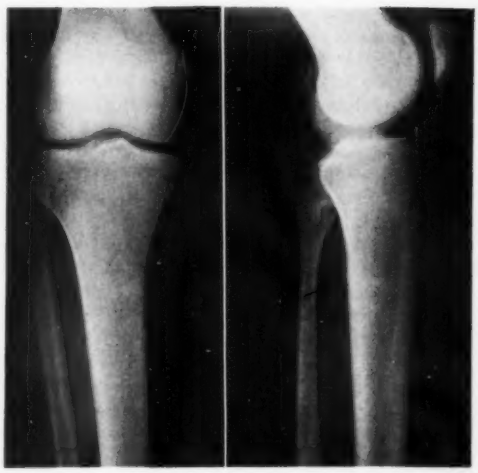

Fig. 1. Case I: Lesion on posteromedial aspect of proximal diaphysis of tibia, with "fraying out" of the cortex and minimal periosteal new bone formation.

Ollonqvist (14), basing his report on twelve years of observation, stated that "march fractures" of the tibia occurred at the rate of 60 a year in the Finnish Army. He called the condition "osteopathia itineraria tibiae" and noted the presence of the fracture line.

Pfahler (15) reported a single case of "insufficiency fracture" of the tibia in 1939, stating that it was the only case of such fracture he had seen, and noting its resemblance to an osteogenic sarcoma. The resemblance to osteogenic sarcoma was also noted by Hansson (7), who reported two fractures of this type in the femur and one in the tibia.

The following cases are illustrative of march fracture of the tibia.

CASE I: A 17-year-old white male enlistee in basic infantry training was admitted to the hospital on Aug. 19, 1950, complaining of pain below the right knee of two weeks duration. Following a 12-mile road march, he had slept on the ground and the next morning noticed "stiffness" of the right

[1] From U. S. Army Hospital, Fort Ord, Calif. Accepted for publication in September 1951.

leg, with a similar sensation, but to a lesser degree, on the left. On resuming the march the following morning, he experienced pain below the knees, more severe on the right, after the first mile or two. The leg felt swollen from the top of his high boot to the knee, and was somewhat tender in the same area. The patient finished the march and the next morning noted that the swelling had disappeared, but the pain on walking and tenderness persisted.

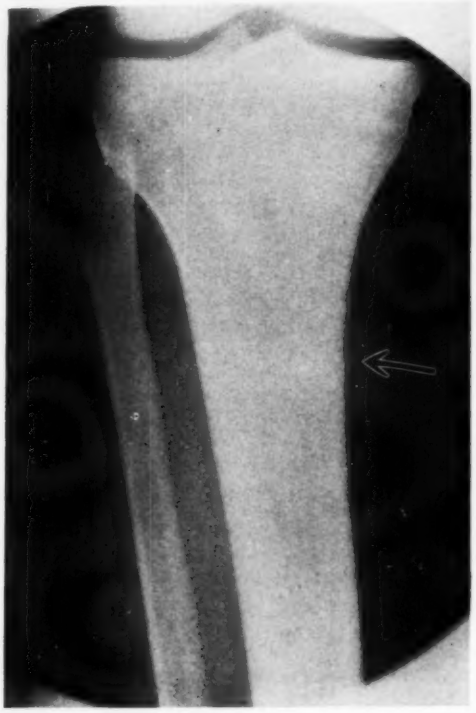

Fig. 2. Case I: Spot film made three days after initial examination, showing periosteal new bone formation. A thin, faint fracture line extends through the adjacent cortex for a short distance.

He was seen on sick call, where a compression bandage was applied and he was placed on light duty for a week. Symptoms persisted and he was again examined and found to have a localized area of tenderness approximately 3 cm. in diameter on the medial aspect of the tibia, about 4 cm. below the knee. There was also a mild degree of induration in this area. The clinical diagnoses considered at this time included osteomyelitis, Ewing's tumor, and osteogenic sarcoma.

Roentgenography (Fig. 1) revealed an area of slight cortical demineralization ("fraying out") with minimal periosteal new bone formation, about 4 cm. in length, on the posteromedial aspect of the proximal diaphysis of the tibia. In the absence of a history of specific trauma, it was considered that the lesion might be inflammatory or neoplastic. Biopsy was considered. Additional films (Fig. 2) were made the following day and it was noted that there was a slight disturbance of the trabecular pattern adjacent to the area of periosteal reaction. A diagnosis of insufficiency ("march") fracture was suggested. The patient was afebrile and all laboratory studies were within normal limits. A subsequent roentgenogram demonstrated an incomplete fracture line through the cortex and an increasing amount of callus. Following immobilization in plaster, symptoms rapidly disappeared. Examination one month later (Fig. 3), showed callus formation and beginning obliteration of the fracture line.

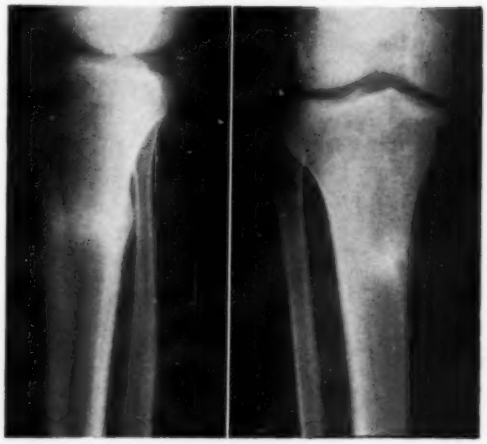

Fig. 3. Case I: Appearance one month after initial examination.

On reviewing the original roentgenograms of the opposite knee, initially reported as negative, it was found that there was a minute amount of periosteal reaction on the posteromedial aspect of the proximal diaphysis of the tibia. In retrospect, this was recognized as a very early march fracture accounting for the mild symptoms in the left leg.

Following removal of the plaster cast and physiotherapy, the patient was asymptomatic and returned to duty after three months hospitalization.

CASE II: A 21-year-old white soldier was admitted to the hospital March 1, 1951, complaining of pain below the right knee of three weeks duration. At the onset of symptoms, he was in his ninth week of basic infantry training. The pain first developed following a 4-mile speed march. It had persisted and was particularly aggravated by marching. Physical examination revealed moderate tenderness and slight swelling and induration over a localized area on the medial aspect of the leg about 5 cm. below the knee. There was no fever; serologic tests were negative, and blood and urine findings

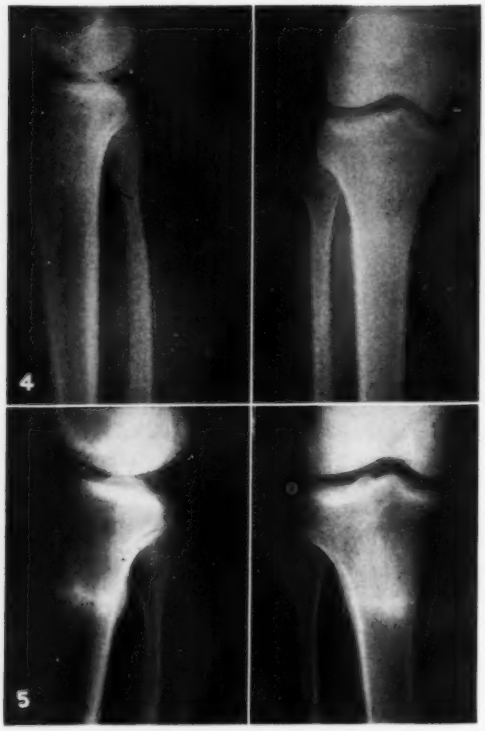

Fig. 4. Case II: Minimal periosteal new bone formation in the typical location for a "march" fracture. Fracture line barely visible on the original.
Fig. 5. Examination three weeks later, showing the incomplete fracture and abundant callus.

were within normal limits. A roentgenogram revealed an incomplete fracture through the cortex on the posteromedial aspect of the diaphysis of the tibia in its proximal third, with periosteal new bone formation in this region (Fig. 4). A plaster cast was applied, with relief of symptoms. The fracture line and callus were more evident on examination three weeks later (Fig. 5). Healing was prompt and the patient returned to duty after eight weeks hospitalization.

CASE III: A white male private, aged 22, was admitted to the hospital April 6, 1951, complaining of pain in the right leg of two weeks duration. He stated that he had suddenly felt pain over the mid-portion of the right lower leg while marching. This had continued until he was seen in the dispensary and referred for x-ray examination. He had noticed some associated swelling and redness of the leg since onset of symptoms. Examination revealed tenderness of the mid-portion of the right tibia, but no swelling, heat, or redness. The patient was afebrile, and laboratory findings were within normal limits. A roentgenogram revealed an incomplete fracture, extending obliquely through the cortex of the mid-shaft of the tibia on its posteromedial aspect, with considerable callus formation (Fig. 6). A small area of periosteal new bone formation was also noted on the lateral aspect of the fibula at a slightly higher level, but no definite fracture line could be demonstrated.

The leg was placed in a plaster cast, and soon became asymptomatic. Examination six weeks later (Fig. 7) demonstrated the fracture line better, but additional callus was present. The fracture healed satisfactorily, leaving practically no evidence of its existence, and the patient was returned to duty, asymptomatic, six weeks after admission. One month later, he returned with a similar fracture of the opposite tibia at a comparable level

CASE IV: A 24-year-old white male, private first class, with seven months service, was first admitted to the hospital on April 14, 1951. He had first noticed pain in his left leg during a road march about two months before admission. This lasted for only two or three days and then subsided. On the day of admission, the patient was standing and watching a ball game, when he again noticed pain in the same region of the leg. He had not had any acute injury. The pain continued and was especially aggravated by walking. The remainder of the history was negative. Upon examination the patient walked with a severe limp and there was diffuse tenderness over the middle third of the left tibia. A roentgenogram at that time showed an incomplete fracture on the posteromedial aspect of the proximal shaft of the tibia about 5 cm. below the proximal articular surface (Fig. 8). A moderate amount of callus was present. The leg was placed in a plaster cast and soon became asymptomatic. A subsequent roentgenogram (Fig. 9) showed satisfactory healing. The patient was returned to duty eight weeks after admission.

ETIOLOGY

"March fracture" of the tibia should logically be assumed to be the result of the same factors which cause the far more common fractures of the same type in the metatarsals. Numerous theories have been advanced to explain the latter. The most commonly accepted mechanism is the summation of minor, subthreshold traumata incident to prolonged marching, (3, 7, 9, 12) or other excessive use of the feet in the unconditioned individual.

Brandt (3) refers to these lesions as "creeping fractures occurring without an obvious single violent trauma, developing insidiously as a result of rhythmically re-

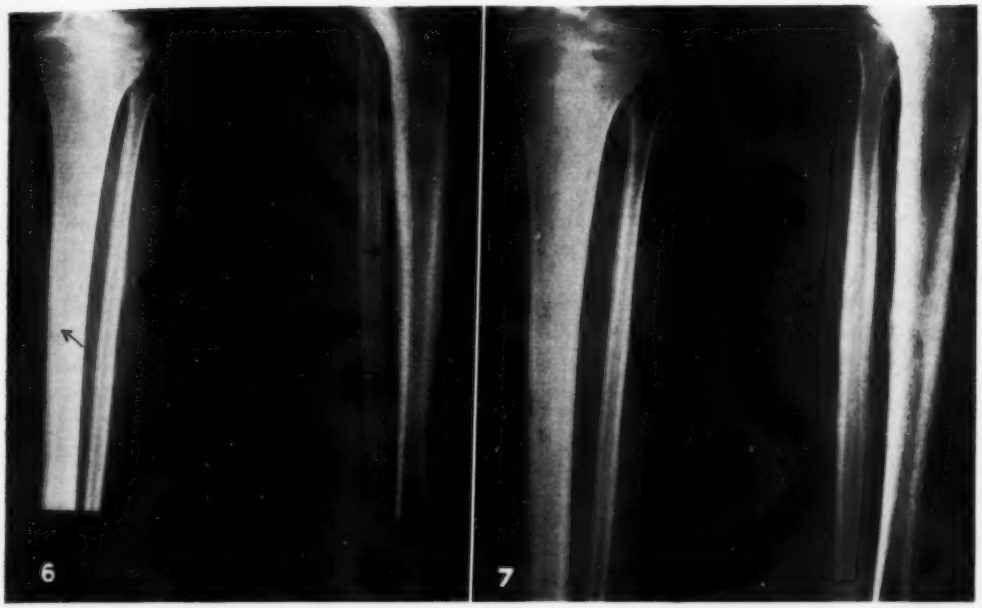

Fig. 6. Case III: The periosteal new bone formation is in the typical posteromedial location, but the incomplete fracture line is barely visible. Periosteal new bone formation is seen on the fibula, but no fracture line was ever demonstrated.
Fig. 7. Examination six weeks later. The fracture line is better visualized, but the fracture is healing satisfactorily.

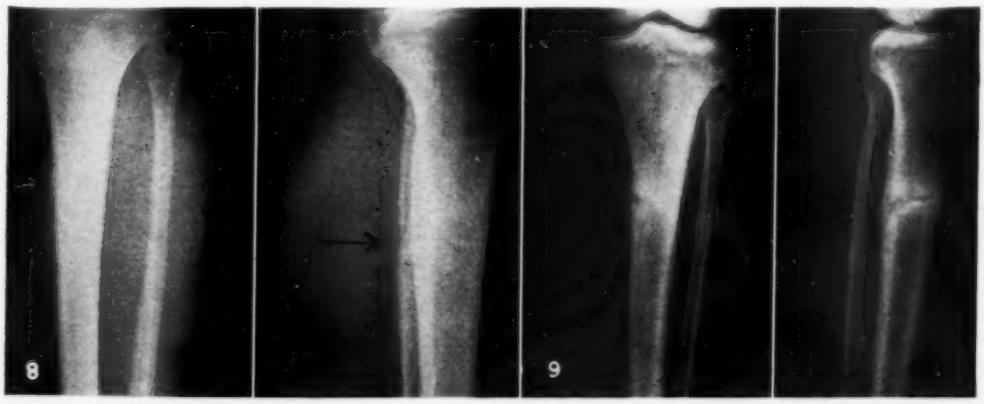

Fig. 8. Case IV: Initial examination, showing a small amount of periosteal new bone formation, but the incomplete fracture line is barely visible.
Fig. 9. Examination five weeks later, showing the fracture line clearly, and abundant callus.

peated, subthreshold, mechanical insults which only by summation lead to structural changes and severance of continuity."

Hullinger and Tyler (9), reporting 313 cases of march fracture, stated that twenty-eight etiological possibilities had been mentioned in the literature, but they believed that "march fracture occurs, not because of mechanical weakness or anatomical variation of the foot or extremity, but as a result of physiological weakness secondary to fatigue that is brought on by

increasing the load the soldier must carry and keeping him going after he tires. As the fatigue increases, the soldier marches not with his muscles "in tone" but relaxed and tired. Mechanically, his weight is borne by the bones and ligaments. This allows repeated micromotion of the bone itself, which eventually breaks much the same as a wire will break with repeated bending."

In non-military personnel, the incidence of march fracture of the tibia is five times as great in the male as in the female (8, 16).

Dew and Wooten (6) report a marked decrease in incidence of "march" fractures of the feet following a gradual increase in length of the marches and of the weight of the equipment carried, and on marching on soft ground. The same prophylactic procedures should apply for march fractures of the tibia.

CLINICAL FINDINGS

The onset of symptoms in military cases normally occurs during the first few weeks of basic training and is commonly noted following a prolonged road march with full pack. Symptoms were commonly present for several days before roentgenograms were requested. Findings on physical examination are quite characteristic and consist of deep localized tenderness, usually with edema, over the site of the lesion, followed by a bony swelling as the callus develops. In no case was there fever, evidence of localized inflammation, or other sign of an infectious process. No patient showed any evidence of a systemic disease or other abnormality of the extremity which could be considered to be a predisposing factor.

ROENTGENOGRAPHIC ASPECTS

The appearance of this lesion is quite characteristic and permits early diagnosis if recognized. In the majority of cases the fracture has been in the proximal third of the shaft of the tibia; all have been on the posteromedial aspect. The fracture line varied from a barely visible irregular line of decreased density extending only a short distance through the cortex on one side to a complete fracture, though there was never significant displacement of the fragments. Periosteal new bone formation was demonstrable in all but two cases at the time of the initial examination, though in several it was so very faint that it could be demonstrated only by technically near-perfect films. In one instance, the fracture line could only be seen when the extremity was in a particular position of obliquity, but the periosteal new bone formation was quite visible in the routine views. Two cases showed a "laminated" appearance of the periosteal new bone. In the early cases, a small localized area of "fraying out" of the margin of the cortex was commonly noted at the initial examination. Subsequently, the fracture line and callus became much more apparent. In 2 cases bilateral fractures occurred. Ten fractures were on the right and 7 on the left. In 1 instance, callus was demonstrated on the lateral aspect of the fibula at the same level as the tibial fracture, but no fracture line was demonstrated in the former. As evidenced by the first case, it is possible initially to confuse the radiographic appearance of this lesion with that of an infectious or neoplastic process. During the period in which these 15 cases of tibial fractures were collected, 2 cases of march fracture of the fibula, 2 of the os calcis, and 1 of the femur have also been observed. Over 200 cases of march fracture of the metatarsals have been seen in the same group of troops during a like period.

TREATMENT

Treatment consisted of immobilization in a plaster cast for approximately six weeks, followed by physiotherapy and graduated exercise, with return to duty in two to three months. An occasional patient had persistent tenderness and required immobilization for a slightly longer period. One remained on duty after the diagnosis was made. No adequate follow-

up was possible in this case since the patient was transferred from the post.

SUMMARY

Fifteen "march" fractures of the tibia have been reviewed and illustrative cases presented. The characteristic appearance, location, and clinical course have been discussed. The majority have occurred in the proximal third of the diaphysis of the tibia with the remainder occurring in the middle third. In all cases the site of fracture was on the posteromedial aspect of the bone. This lesion, in its early stages, may resemble a neoplastic or inflammatory process. These fractures will be seen in considerable numbers in any of the military centers where new recruits are being given arduous basic training. Early diagnosis is possible and will preclude prolonged observation, or conceivably biopsy, and insure prompt and adequate treatment.

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SUMARIO

Fractura de la Tibia en Marcha

Repásanse aquí casos de fractura de la tibia, experimentada al marchar, presentándose casos típicos. Discútense los característicos aspectos, localización y evolución clínica. La mayoría de esas fracturas correspondieron al tercio proximal de la diáfisis de la tibia, correspondiendo los demás al tercio medio. En todos los casos, el sitio de la fractura quedaba en la cara posteromedial del hueso. En sus primeras etapas, la lesión puede semejar un proceso neoplásico o inflamatorio.

Esas fracturas se observarán en número considerable en cualquiera de los centros militares en que nuevos reclutas reciben arduo adiestramiento. El diagnóstico temprano es posible y evitará observación prolongada, y concebiblemente la biopsia, y asegurará tratamiento rápido y adecuado de la lesion.

Fundamentals of Interpretation in Step Kymography[1]

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A ROENTGENKYMOGRAM is a continuous record of motion—as considered here, of the heart—obtained by means of the roentgen ray. Several methods have been developed to obtain this record:

(*a*) The single slit grid, invented by Sabat in 1911.

(*b*) The multiple parallel slit grid of Pleikart Stumpf, which may be used with the grid moving, to give a plane kymogram, or with the film moving, to give a step kymogram.

(*c*) The adjustable slit kymogram described by Crane in 1916.

(*d*) The vector grid, invented by Stumpf in 1931 and subsequently popularized by Morelli.

(*e*) The electrokymogram, pioneered by Henny and Boone in 1945.

All these methods yield curves or waves representative of motion. In all instances the time axis of a beating heart is converted to a distance axis on photographic film or paper. With allowance for varying degrees of efficiency, all methods provide similar, if not identical, wave forms. Since the recording is founded upon physical principles, within the limits of these principles the record is a factual one.

Interpretation of the kymogram, unfortunately, is not always factual. Errors, both of commission and omission, creep into interpretation. To avoid some of them, the recognition of certain principles is recommended.

First, the physician should approach the kymogram as a physiologist and a cardiologist, not as a radiologist. The recording here is one of cardiovascular dynamics. The only connection between the kymogram film and the routine roentgenogram is that both are produced by x-rays. The physician should also recognize that a kymogram is a diagnostic adjunct, taken to answer a specific question concerning movement, and not a complete examination in itself. With the possible exception of ventricular aneurysm, there are no pathognomonic kymographic patterns.

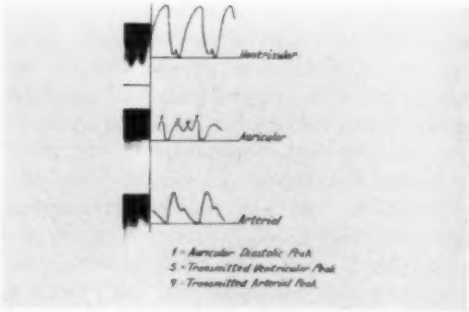


Fig. 1. Charting of the normal waves.

With this in mind, a uniform procedure to organize the information which one may obtain from the film is necessary. Using step kymography, the following is suggested.

1. The frames are related to the cardiovascular *Gestalt*. It is a merit of the step kymogram that a separate localizing film is unnecessary, since the multiplicity of frames permits identification of the heart, great vessels, and larger tumor masses. Although the *Gestalt* is discontinuous, like a figure seen through a venetian blind, it is easy to match the frames to their proper anatomical location.

2. The time relationships of the waves in different frames are determined next. Having on hand a postero-anterior view made with the slits horizontal, the viewer places the film on the viewing box so that the images of the slits run vertically; the diaphragm is at his left, the lung apices

[1] From the Department of Radiology, The Henry Ford Hospital, Detroit, Mich. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Dec. 2–7, 1951.

at his right, and the side of the heart under examination up. In this transverse position, the time axis runs horizontally (on the abscissa), and amplitude runs vertically (on the ordinate). The turning of the film over between examination of the right and left borders is of no consequence, because a kymogram film does not have a front and back in the sense of an equivalent roentgenogram.

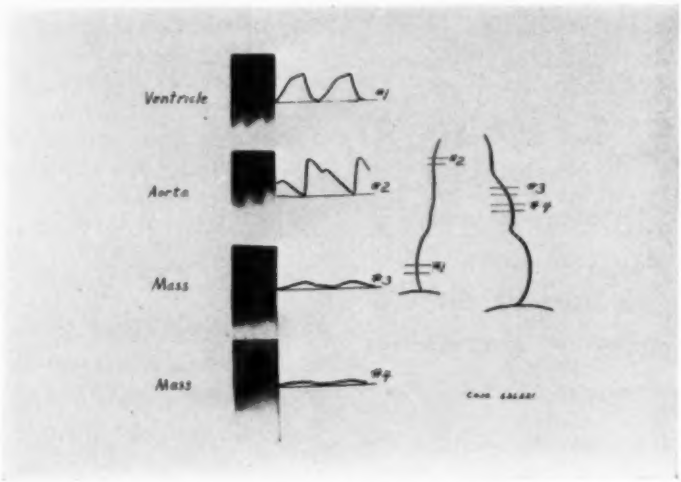


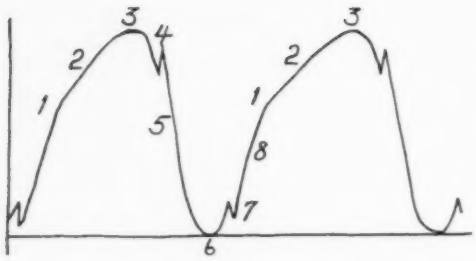
Fig. 2. Charting of the waves of a patient with a pericardial cyst.

To identify time relationships between waves, the distance from the start of a given frame to a fixed point in the cardiac cycle is compared with the same distance in the other frames. As a convention, one may begin with a ventricular type of wave on the left border, measure the distance from the slit line to the first fully outlined systolic trough, and set dividers at this distance. Proceeding with one frame after the other along both cardiovascular borders, one matches this distance with the cardiac cycle as therein recorded. Synchronization or lack of synchronization with ventricular apical systole of points 1.2 cm. apart along the right and left heart borders, the vascular pedicle, and any tumor mass may be detected.

3. The third step is the charting of waves from selected frames on graph paper, to the same scale, and one below the other in parallel arrangement, so that the time co-ordinates may be easily compared. With the kymogram on the viewing box as described, a horizontal base line is drawn on the film, starting at the slit to the left of the frame and running tangent to the trough or troughs of the waves within this frame. A similar base line is reproduced on the graph paper. With the dividers, it is possible to transfer a few points from the film to the paper, then connect them freehand to reproduce the wave. In charting, one takes cognizance both of amplitude and of timing. Excessive meticulousness is unnecessary because the original is available for comparison and because slight variations in wave form are of doubtful significance (Figs. 1 and 2).

4. The last step in the procedure is the often neglected notation of density lines. These, the kymographic equivalent of contraction, may be crosshatched in the appropriate position on the chart. This should be done with the arterial waves as well as the ventricular.

A fixed procedure as given here aids in the recognition of the ideal forms of the three basic types of kymogram waves, the sequence of events within each wave,



1 Diastatic Point
2 Active Segment of Diastolic Leg
3 Diastolic Peak
4 Systolic Serration
5 Systolic Leg
6 Systolic Trough
7 Diastolic Serration
8 Passive Segment of Diastolic Leg

Fig. 3. The ideal ventricular wave.

and deviation from the ideal form. The three basic types are ventricular, auricular, and arterial.

THE VENTRICULAR WAVE

The ideal ventricular wave (Fig. 3) presents the following sequence of events:

1. *Diastatic Point:* Since this point corresponds to the P wave of the electrocardiogram, it provides a suitable beginning in the terminology of the ventricular wave. It represents the beginning of auricular contraction. Although the exact position may be indefinite in any one frame, its location may be approximated by extending the general curves of the active and passive segments of the diastolic leg toward each other.

2. *Active Segment of the Diastolic Leg:* Auricular systole actively fills the ventricles.

3. *Diastolic Peak:* The correlation is with the QRS complex of the electrocardiogram, isometric ventricular contraction, and closure of the atrioventricular valves.

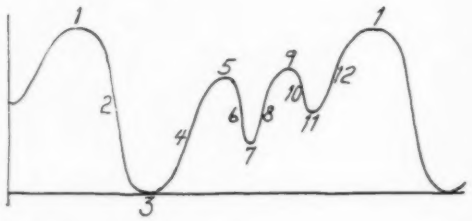
4. *Systolic Serration:* This little notch found near or shortly following the diastolic peak corresponds to the opening of the semilunar valves, and to the first heart sound.

5. *Systolic Leg:* From an initial abrupt, downward movement, the lower part curves into the density line to form the systolic trough.

6. *Systolic Trough.*

7. *Diastolic Serration:* A notching is frequently found on the diastolic side of the trough. It correlates with the closing of the semilunar valves, the end of physiologic aortic regurgitation, and the second heart sound.

8. *Passive Segment of the Diastolic Leg:* Under venous pressure against relaxed ventricular muscle and through open atrioventricular valves, the ventricles dilate.



1 Auricular Diastolic Peak
2 Auricular Systolic Leg
3 Auricular Systolic Trough
4 First Auricular Diastolic Leg
5 Transmitted Ventricular Peak
6 First Return Leg
7 First Return Trough
8 Second Auricular Diastolic Leg
9 Transmitted Arterial Peak
10 Second Return Leg
11 Second Return Trough
12 Third Auricular Diastolic Leg

Fig. 4. The ideal auricular wave.

THE AURICULAR WAVE

The opinions expressed in the literature as to the interpretability of auricular waves vary from the view that they are not subject to analysis to one that correlates them with the jugular pulse. Neither

is quite correct. Despite the low amplitude, rapidity, and poor detail of the movements, by taking a large number of kymograms and charting all the frames from atriovenous regions with the selected frames containing neither ventricular nor arterial wave forms, and by utilizing the newer electrokymographic results, one can develop a scheme for the ideal auricular wave.

The scheme is essentially that of auricular systole followed by auricular diastole. Superimposed upon diastole is a transmitted ventricular peak, produced by ventricular systole, and a transmitted arterial peak that is simultaneous with the closing of the semilunar valves. The ideal auricular wave consists of three small peaks and three small troughs for each cardiac cycle (Fig. 4).

1. Auricular Diastolic Peak: The diastatic point of the ventricular wave and the P wave of the electrocardiogram are simultaneous.

2. Auricular Systolic Leg: The filled auricle contracts to fill the ventricle actively, with counterpressure provided by the venous reservoir ("*a*" wave of jugular pulse).

3. Auricular Systolic Trough: The ventricular diastolic peak and the QRS complex occur at this time.

4. First Auricular Diastolic Leg.

5. Transmitted Ventricular Peak: This and the preceding are related to ventricular systole. The direct cause may be a pressure wave from the bulging leaflets of the atrioventricular valves. The "*c*" wave of the jugular pulse approximates this in time.

6. First Return Leg: As ventricular systole subsides, the referred pressure on the auricular blood lessens.

7. First Return Trough: This may be imagined as the position the edge of the auricle would have been in had not a ventricular contraction intervened.

8. Second Auricular Diastolic Leg.

9. Transmitted Arterial Peak. Two forces are presumed to operate: the continued diastolic filling of the auricle and the impact of the closing of the semilunar valves. The timing of the peak is with the diastolic serration and the second heart sound.

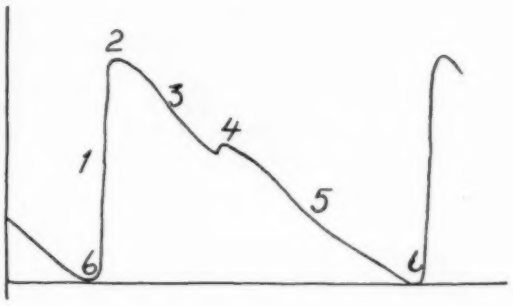


Fig. 5. The ideal arterial wave.

10. Second Return Leg.

11. Second Return Trough: Like the comparable first return leg and trough, this is a return to *status quo*.

12. Third Auricular Diastolic Leg: The auricle completes its filling with blood from the venous reservoir. There may be some dilatation from physiologic mitral and tricuspid regurgitation.

THE ARTERIAL WAVE

Identical arterial waves are produced by the aorta and the pulmonary arteries, and direction of blood flow does not alter the form or sequence of events (Fig. 5).

1. Expansile Leg: Under the influence of ventricular systole, the artery distends. This is the pulse beat.

2. Arterial Peak.

3. First Arterial Return Leg: The duration of this leg corresponds to the period of physiologic aortic and pulmonic regurgitation.

4. Arterial Serration: The second heart sound, the closing of the semilunar valves,

the transmitted arterial peak of the auricular wave, and the diastolic serration of the ventricular wave are all cotemporal.

5. Second Arterial Return Leg: Vascular elasticity reduces the vessels' caliber and propels the blood distally.

6. Arterial Trough.

SUMMARY

A few concepts are presented which may aid one in kymographic interpretation. The concepts concern attitude, principles of procedure, and recognition of ideal wave forms.

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SUMARIO

Fundamentos de la Interpretación de la Quimografía

Por medio de la roentgenoquimografía se obtiene, con la ayuda de los rayos X, un registro continuo del movimiento del corazón. Ese registro es, en sí mismo, un dato preciso, mas su interpretación es susceptible de ciertos errores. Con mira a evitarlos, ofrécense algunos conceptos relativos a la actitud del examinador, los principios que gobiernan el procedimiento y el reconocimiento de las formas ideales de onda.

La actitud del médico debe ser fundamentalmente la del fisiólogo, dado que el registro versa sobre la dinámica cardiovascular. Además, tiene que reconocer que el quimograma es meramente un auxiliar diagnóstico y no un examen completo.

En resumen, los tiempos comprendidos en la organización de la información obtenida son: (1) ajustar los marcos (registros sucesivos) a la debida localización anatómica, (2) establecer la relación cronológica de las ondas en diversos marcos; (3) trazar las ondas procedentes de marcos escogidos en papel de gráficas, a la misma escala, una debajo de otra, en orden paralelo, a fin de poder comparar fácilmente las coordenadas cronológicas; (4) anotación de las líneas de condensación, que constituyen el equivalente quimográfico de la contracción.

Partiendo de esa base, trázase la evolución de los acontecimientos en las formas ideales de los tres tipos básicos de ondas quimográficas: ventriculares, auriculares y arteriales.

DISCUSSION

Wendell G. Scott, M.D. (St. Louis, Mo.): Dr. Wangner has developed an orderly method for the careful analysis and interpretation of the waves on the kymogram. This is very desirable, as it is more effective to have a systematic routine for the study of the roentgenogram in any type of examination and is perhaps more important in the interpretation of kymograms. These waves record the change in position of multiple points on the border of the heart during systole and diastole. By the careful application of Dr. Wangner's technic, one can often derive more information from

them than can be obtained from a casual observation. This is particularly true with respect to the auricular waves, which are always very difficult to interpret. As Dr. Wangner pointed out, they are really a composition of the auricular movements plus the superimposed ventricular movements.

As was mentioned, it is the change in the size or amplitude of the waves that is the most important significant observation, although alterations in the contour of the waves, in my experience, have also been important in arriving at a diagnosis in a few conditions.

We must always keep in mind that the kymogram is an examination of the heart whereby the dynamic movements and physiologic changes of various points on the contour of the chambers of the heart are recorded. These waves are rather difficult for the average cardiologist to evaluate because he is not familiar with kymography. Furthermore, he employs other examinations and tests that often give him the same information. Consequently, it is not necessary for him to refer to the kymogram. That is the chief reason why kymography has not been used as widely as we might think desirable.

Dr. Wangner is to be commended for the excellent method he has devised for studying the kymographic waves. I am sure, if his procedure is followed, it will provide more information from the kymograms.

A Syringe Wired for Automatic X-Ray Exposure[1]

NATHAN FLAX, M.D., and ROBERT WALDRON[2]

IN THE MAKING of a translumbar aortogram an important consideration is the immediate sequence of the x-ray exposure following the introduction of the medium into the aorta. When the timing of exposure following the injection is dependent upon a signal from surgeon to radiologist, there may be a lag of variable degree; the desired timing may be off, and there result unspoken recriminations between surgeon and radiologist. It seemed to the authors that an automatic sequence would yield a consistently satisfactory aortogram. To this end, a syringe was developed in which was incorporated an electrical switch wherein the firing mechanism was automatically engaged at any predetermined point, so that, upon the completion or near completion of the dye injection, the exposure followed automatically.

As far as could be determined, no such syringe has been described in the literature, though it appears most likely that such syringes have been made by others. Our syringe is constructed as follows:

An ordinary glass syringe with a metal barrel is used, the connecting rod being lengthened about 3/4 inch for the addition of the necessary thicknesses of the bakelite disks used to insulate the wiring from the metal barrel and other parts of the syringe. As a further safeguard from shock hazard, only 6 volts are used at the syringe. Upon closing the 6-volt circuit, a relay is actuated to close in turn the 110-volt x-ray exposure switch. On the syringe side, the contacts are spaced far apart to avoid premature "shorting" by conducting fluids. Test immersion of the contacts in supersaturated salt solution does not actuate the relay.

As noted in the diagram (opposite page), the upper half of the switch is completely separate from the lower half and there can be no accidental, premature closing of the circuit. All screw heads are recessed and covered with insulating cement. Repeated sterilization has not injured the insulating materials.

Synchronization can be adjusted so that exposure takes place at or just before the end of the complete dye injection.

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SUMARIO

Jeringa Alambrada para Exposición Automática a los Rayos X

Para regular la duración de las exposiciones en la aortografía translumbar, empléase un accesorio diseñado *ad hoc*. Consta de una jeringa de vidrio (con cañón de metal), a la cual va unido un conmutador eléctrico, cuyo mecanismo impulsador encaja automáticamente en cualquier punto predeterminado, de modo que la exposición a los rayos tiene lugar también automáticamente ya al terminar, o precisamente antes de terminar, la inyección de la substancia de contraste.

[1] From the Department of Radiology, Wm. Booth Memorial Hospital, Covington, Ky. Accepted for publication in October 1951.

[2] Captain, Salvation Army.

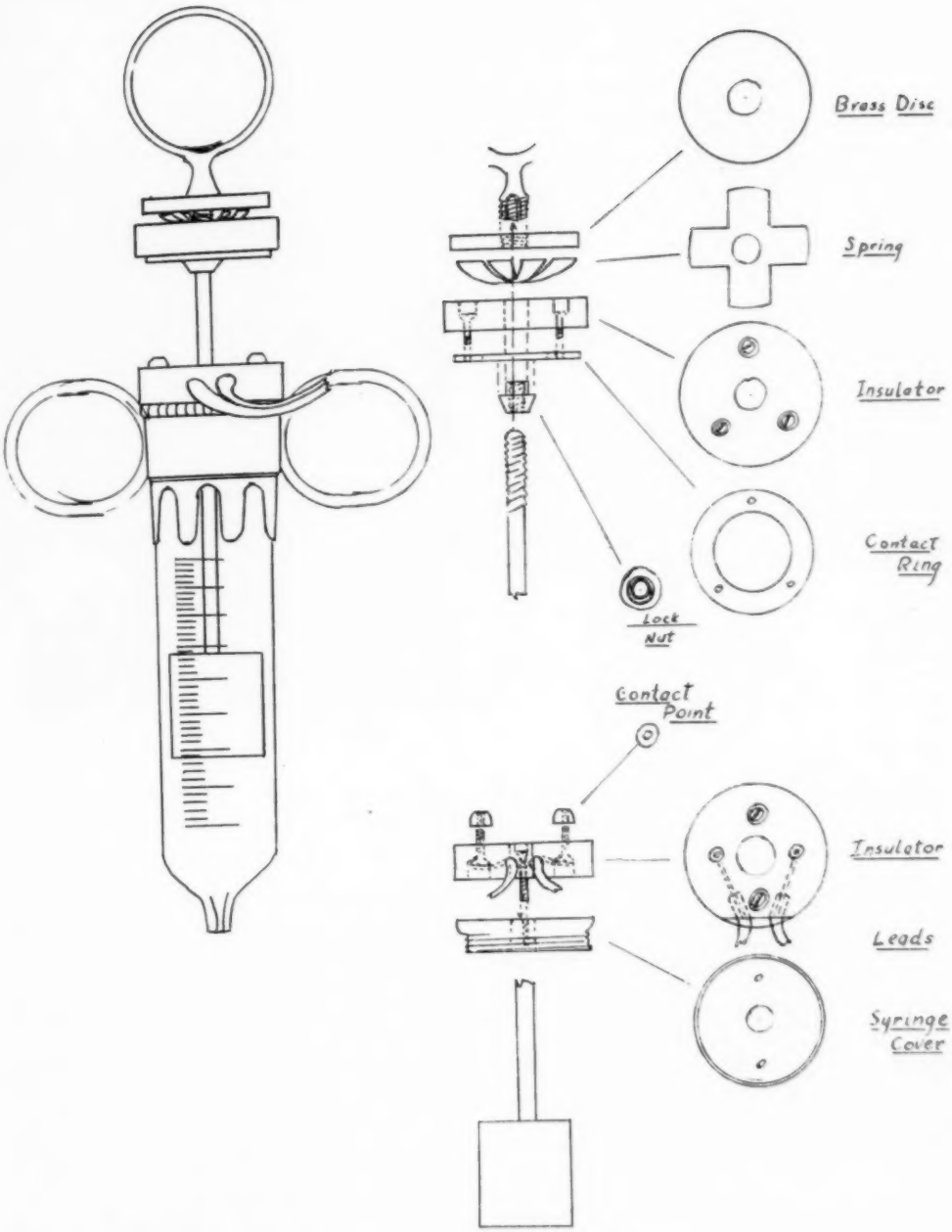

Fig. 1. Construction of syringe wired for automatic x-ray exposure

Diversion of Venous Blood Flow Through Transverse Sinuses in One-Sided Innominate Vein Obstruction[1]

A. SCHWARTZ, M.D., and M. FRAENKEL, M.D.

Jerusalem, Israel

THE LITERATURE contains many reports of superior vena cava obstruction (1) but few of one-sided innominate vein obstruction with the superior vena cava remaining patent. Such reports of innominate vein obstruction as have appeared deal mainly with the clinical findings, without demonstration by phlebography of all possible routes of blood-flow diversion from the affected area (2, 3). As far as we could ascertain, the case to be reported here is the first in which the transverse sinuses were demonstrated by the injection of contrast medium into the cubital vein. It came to our attention in the course of angiography for the diagnosis of mediastinal lesions.

S. K., a 30-year-old male, two years before admission to our hospital noticed swelling of his face and both arms, and a mass above the left clavicle, the size of a hen's egg. A diagnosis of Hodgkin's disease had been made at that time (Fig. 1). After x-ray therapy the supraclavicular mass and the swelling of the face disappeared, and the patient felt well until about six months before admission, when he began to experience a dull ache behind the right sternoclavicular junction, radiating into the right shoulder. At the same time he noticed swelling of the right arm and shoulder, appearing after exercise and disappearing with rest. The face and the left arm remained unaffected.

Clinical examination revealed no abnormalities, except for a persistent fullness of the right jugular vein. Venous pressure readings were as follows: in the right arm, 20 cm. H_2O; in the left arm, 10 cm. H_2O. The circulation time (Decholin), right arm to tongue was 19 seconds; left arm to tongue, 10 seconds.

A film on admission showed a normal mediastinal shadow and increased markings of the right upper lung field, due probably to radiation fibrosis.

Phlebography (Fig. 2) with 30 c.c. of diodrast (35 per cent) injected into the right cubital vein, with the patient sitting, showed complete obstruction of the right innominate vein with reflux of contrast medium into the jugular vein. No collaterals were visible. Phlebography with injection of the left cubital vein, under same conditions, revealed normal filling of the left innominate vein and superior vena cava.

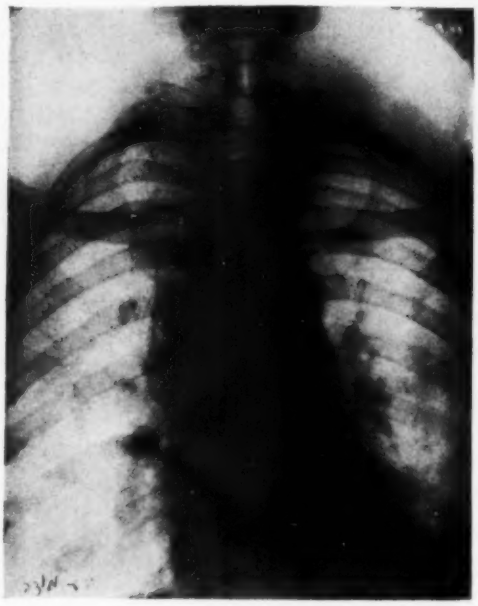

Fig. 1. Upper mediastinal shadow enlarged, mainly to the right.

As no collaterals except the cervical veins (thyroid veins) could be demonstrated, the conclusion was reached that the venous blood flow from the right arm, right shoulder, and the right half of the neck must be diverted through the dural sinuses of the skull to the left jugular vein, reaching finally the superior vena cava.

To prove this assumption, 60 c.c. of diodrast (35 per cent) was injected into the right cubital vein, and exposure of film made twelve seconds after start of injection (injection time ten seconds). The resulting phlebogram (Fig. 3) shows good filling of the right and left jugular vein, with some contrast medium in the left innominate vein.

A roentgenogram of the skull (Towne's position) obtained after injection of 50 c.c. of diodrast (70 per cent) into the right cubital vein, shows filling of

[1] From the Diagnostic X-Ray Department of the Hadassah University Hospital (Head: Prof. A. Druckmann, M.D.), Jerusalem, Israel. Accepted for publication in July 1951.

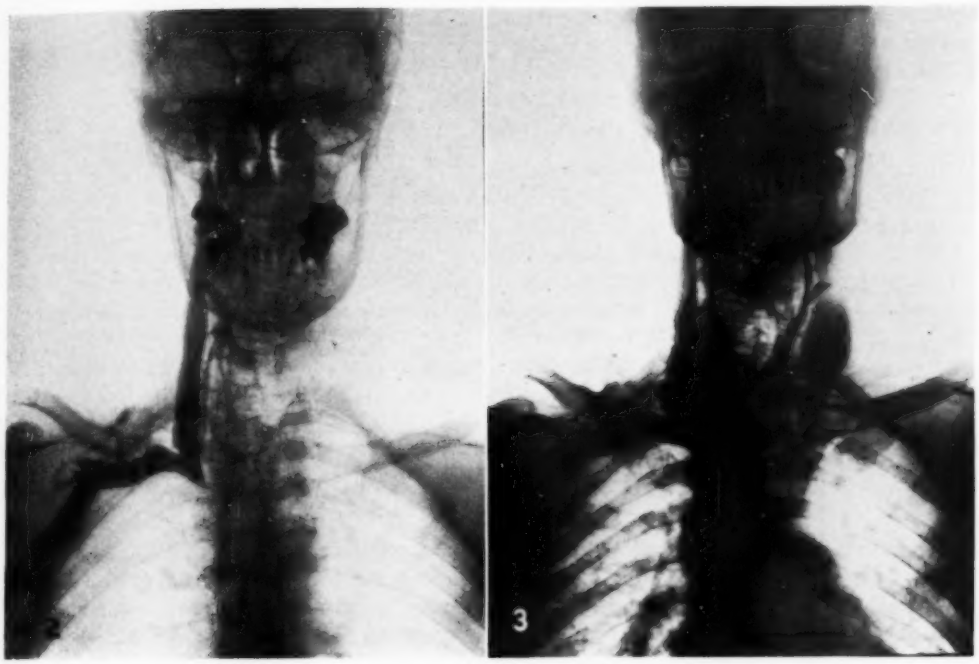

Fig. 2. Phlebography (30 c.c. of diodrast, 35 per cent, injected into right cubital vein). Filling of the right axillary, subclavian, and internal jugular vein. Diodrast seen up to petrous bone. Abrupt obstruction to contrast medium after junction of subclavian and internal jugular vein.

Fig. 3. Phlebography (60 c.c. of diodrast, 35 per cent, injected into right cubital vein). Filling of both internal jugular veins, with some contrast medium in cervical veins, left innominate vein, and superior vena cava. Note dilatation of the distal end of the left jugular vein, due most probably to the mass in the left supraclavicular region, at the time patient noticed swelling of the face.

both transverse sinuses and part of the superior sagittal sinus (Fig. 4), thus completing the link between the right cubital and left innominate vein.

DISCUSSION

As demonstrated by phlebography in our case, the main channel of diversion of the venous blood flow in innominate vein obstruction is through the transverse sinuses. Gurdjian *et al.* (6) reached a similar conclusion on performing a carotid-internal jugular shunt in the Rhesus monkey. Katz *et al.* (2, 3) have reproduced a roentgenogram much like our Figure 2, and we assume that these authors would have arrived at a conclusion similar to ours had they radiographed the skull after injection of contrast medium.

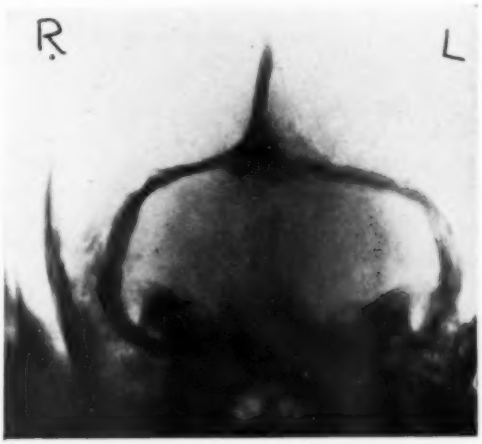

Fig. 4. Skull (Towne's position) after injection of 50 c.c. of diodrast, 70 per cent, into the right cubital vein. Filling of the first part of right internal jugular vein, both transverse sinuses, torcular Herophili, and part of the superior sagittal sinus. Note the continuity of the right transverse sinus with the superior sagittal sinus and a separate connection between the two transverse sinuses.

SUMMARY

1. The main channel of diversion of the venous blood flow in a case of complete

obstruction of the right innominate vein proved to be through the transverse sinuses to the contralateral internal jugular vein.

2. The first demonstration of the transverse sinuses by injection into the cubital vein is reported.

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SUMARIO

Desviación de la Circulación Venosa a Través de los Senos Transversos en la Oclusión Unilateral del Tronco Braquiocefálico

Preséntase un caso de oclusión total del tronco venoso braquiocefálico derecho, en el cual el principal conducto de desviación de la circulación venosa resultó ser, a través de los senos transversos, a la vena yugular interna contralateral. Esta parece ser la primera vez que se hayan revelado los senos transversos mediante la inyección de un medio de contraste en la vena cubital.

Measurement of Beta-Ray Applicators[1]

J. KASTNER, Ph.D., and L. GREENBERG, M.Sc.

Ottawa, Ont.

THE BETA-RAY applicator is a source of very intense beta radiation giving a high radiation dose rate to a small restricted volume of tissue. The ophthalmic applicator, described in detail by Swanberg (10), may have several millicuries of radium-D + radium-E (Ra-D+E), or other beta-emitting isotope, deposited on an area of about 0.25 square centimeter and protected by a thin metal foil.

The high activity, small physical size, and relatively short range of the particles, which are all advantages in surface treatment, have made the measurement of the dose rate very difficult. As a result large discrepancies have occurred in measurements of the dose rate from Ra-D+E ophthalmic applicators recently produced.

Previous measurements (4, 9) have given the surface dose rate as averaged over a large area of the applicator, and the half-value layer averaged similarly. The surface dose rate of a typical ophthalmic applicator (which appears to have a very uniform distribution of the active material) actually varies rapidly along the small diameter (5.6 mm.), as will be shown (Fig. 1). The methods developed by Neary (9) and Spiers (4) are not readily adapted to such small applicators. The apparatus developed here may be used to measure an applicator of any size and for beta energies in excess of about 0.2 mev.

Various quantities have been used in the calibration and determination of the medical value of beta-ray applicators. These measures are the quantity of active material, the contact dose rate or average surface dose rate, and the depth dose rate distribution along the center line. All of these fail, in some respect, to indicate the biological effect on tissue at any particular point, especially in the case of very small ophthalmic applicators.

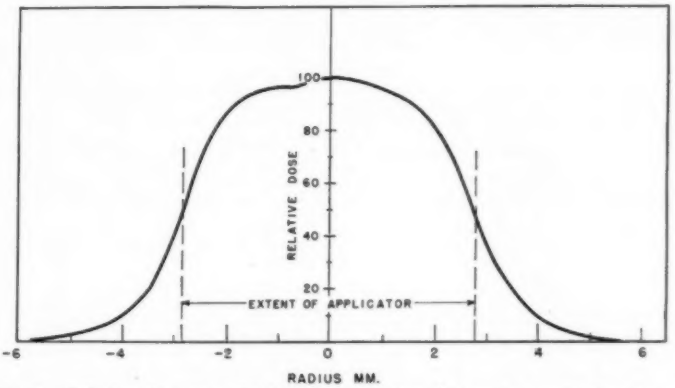

Fig. 1. Relative dose rate obtained from a microphotometer trace of an autoradiogram; no absorber.

Two applicators may be constructed of identical size, and having the same number of millicuries of the same radioactive material, but they may differ in surface dose rate, depth dose rate distribution, or total energy output, as a result of differences in absorption or back-scattering. Thus the *quantity of active material*, which may be

[1] From the Radiology Laboratory, Physics Division, National Research Council of Canada, Ottawa, Ontario, Canada. Accepted for publication in October 1951.

determined when the applicator is being produced, is not a reliable measure of the biological effect or medical value of an applicator.

In the cases where the biological effect of beta-ray applicators has been related to the contact dose rate or *average surface dose rate*, no account seems to have been taken of the lateral dose rate distribution or the fact that the applicator expends practically all of its available energy within a millimeter or two of the surface. *Average depth dose rate* curves have also been supplied whose shape depends on the distribution of particle energies, and thus in turn on absorption and back-scatter. These curves, which describe the variation with depth along the center line, of the average dose rate, are, like the surface dose rate, an insufficient indication of the actual biological effect on tissue at any particular point, since the specific lateral distribution and extent of the dose rate are ignored. A somewhat analogous condition pertains in the case of soft x-rays, where it has been shown (7) that the biological effect at any point depends, within certain limits, upon the damage effected in the neighboring tissue.

To avoid the above-mentioned limitations, consideration was given to the calibration of small ophthalmic beta-ray applicators by their *total energy output* rather than by surface dose rate or millicurie content. Beta radiation, in being absorbed, causes the break-up of molecules or chromosomes and hence damages the cells. Each break requires, on the average, a given amount of energy, and the biological effect will then be related to the total energy expended in the small volume in which the ionization takes place. Thus one would expect that applicators ought to be compared by energy output. Blau and Smith (3) have also proposed that total energy be used for applicator calibration.

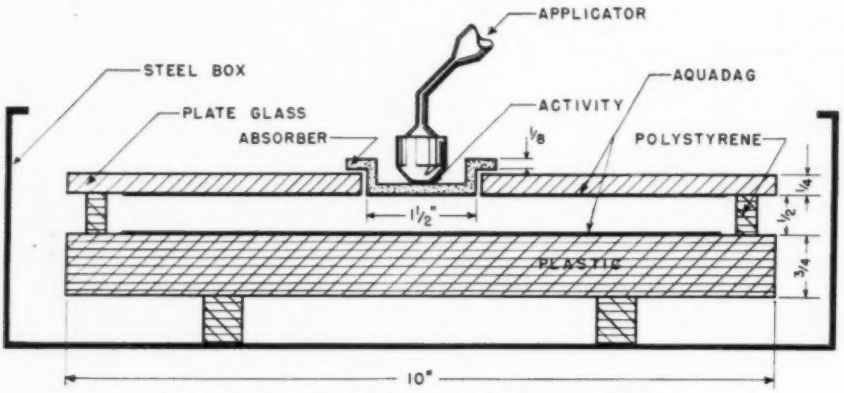

Fig. 2. Cross section of the assembled ionization chamber.

Total energy measurements have not been made in the past because the energy involved, of the order of 10 to 100 ergs per second (one calorie is 41.85 million ergs), is too small to be measured by ordinary methods. This energy output is at the lower limit of measurement by elaborate microcalorimetry and thus does not lend itself to routine determination. The use of a large ion chamber, or high-pressure ion chamber, to collect all the ions formed in a gas, has been suggested. The large mass of gas required to stop the beta rays in a chamber, and resulting large ion current (about 10^{-7} amperes), would require prohibitively high voltages to get saturation conditions.

A method of determining the total energy of beta-ray applicators was developed here whereby certain advantages over the traditional ways of measurement could be realized. The method uses a thin parallel-

plate ion chamber, effectively infinite in extent, inserted at various depths in tissue-like absorbing material to obtain the energy loss at any depth. A graphical integration then gives the total energy of the emerging radiation.

An immediate advantage of this measurement is the production of *isodose curves* which describe the energy loss at any point in the tissue. To obtain the isodose curves, the distribution of the energy at each depth at which the ion chamber measurements were made is determined by an autoradiogram. By comparing the autoradiogram with the corresponding ion chamber result, the energy loss or dose rate at any point at that level may be determined. A series of measurements such as will be described enables depth dose rate and surface dose rate curves to be plotted.

A. TOTAL ENERGY OUTPUT

Before determining the energy output of the applicator experimentally, it is possible to anticipate the value by calculation.

Calculated Energy Output and Average Surface Dose

Total Energy Output: If the activity of the material on the applicator is known, the energy output is estimated from

$$E = 59.2\, A\bar{E}ge^{-\mu x} \text{ ergs/sec.}$$

where A is activity in millicuries, and $\bar{E}$ average energy of the betas in mev. The fraction of particles that emerge is the geometry factor g. The thickness of the protective covering is x and the absorption coefficient for the covering is μ. For Ra-E, the average energy of the beta particles has been measured by many workers and a summary by Myers (8) can be averaged to give $\bar{E} = 0.336 \pm 0.008$ mev. The geometry factor g is 50 per cent for an applicator. Corrections for back-scattered radiation are not attempted here.

The activity of the applicator used was measured by the manufacturers as 5.4 mc. The magnesium foil which covered the activity was 17.5 mg./cm.^{2} thick and the absorption coefficient was measured to be 0.01757 per mg./cm.^{2} of cellulose acetate just outside it. Considering electron density, 17.5 mg./cm.^{2} of Mg is equivalent to 16.3 mg./cm.^{2} of cellulose acetate.

Using these figures, an estimate of the output of the applicator is 40 ergs/sec.

Average Surface Dose Rate: The surface dose is given by the energy being absorbed at $x = 16.3$ mg./cm.^{2} The energy being lost in an infinite plane was empirically shown in this case to follow exponential absorption, and it can then be represented by

$$\frac{dE}{dx} = 59.2\, A\bar{E}g\mu e^{-\mu x} \frac{\text{ergs cm.}^2}{\text{mg. sec.}}$$

The energy at the surface is lost not in an infinite plane but only over the area of the applicator. A loss of 83 ergs per gram of tissue is designated as one rep(5).[2] Correcting for the differences in the absorption of cellulose acetate, for which μ was measured, and tissue, the average surface dose rate from an applicator of area, a, is

$$\text{dose rate} = 42.8\left(\frac{94}{90.5}\right)\frac{1{,}000\, A\bar{E}g\mu e^{-\mu x}}{a} \text{ rep/min.}$$

The factor 94/90.5 is the correction from cellulose acetate to tissue. For this applicator, the average surface dose rate is then expected to be about 2,000 rep/min.

Experimental Determination of Energy Output

Theory of the Infinite Plane Cavity Chamber: The ion chamber used to measure the energy output consisted of a narrow gap between two planes of equivalent and almost tissue-like material. A cross section of the chamber is shown in Figure 2. An absorber in front of the applicator formed part of one of the planes. The ion current in the gap was a measure of the energy loss by the beta radiation at the depth in the absorber material equiva-

[2] The rep, roentgen-equivalent-physical, is the amount of radiation which produces in tissue the same amount of ionization as produced by 1 roentgen of gamma-rays in air, that is, 1 esu per c.c. at S.T.P., or 83 ergs per gram of air.

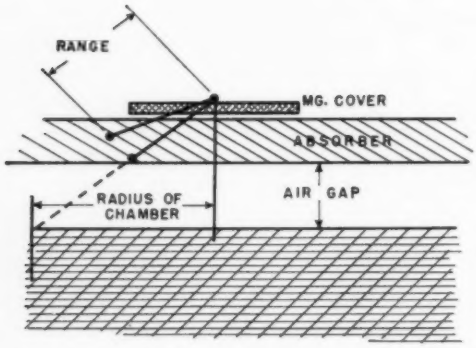

Fig. 3. The largest angle from the normal for the beta particles which enter the air-gap is the angle for which the inclined path is the maximum range. The chamber is effectively infinite in lateral extent when all the beta rays which come through the absorber reach the other plate.

lent to the absorber thickness plus half the equivalent thickness of the air gap. If we let this depth be x, and the energy dissipation be $\left(\frac{dE}{dx}\right)_x$, then the integral over all absorber thicknesses,

$$\int_0^\infty \left(\frac{dE}{dx}\right)_x dx$$

is the total energy output of the applicator that goes through the plane of the surface of the applicator. This integral was obtained empirically after finding values of $\left(\frac{dE}{dx}\right)_x$ for a number of absorber thicknesses.

The chamber was effectively infinite when all the betas which came through the absorber passed through the air gap and entered the other plate. The maximum range of Ra-E betas in cellulose acetate is about 0.33 cm., and in magnesium 0.27 cm. The largest angle from the normal of a beta particle which would just get through the magnesium foil cover and an absorber would be the angle for which the inclined path is the maximum range. Figure 3 illustrates this.

The diameter and separation of the ion chamber had to be chosen so that this peripheral particle would not leave the collecting volume. The thinnest absorber relied on was 0.0127 cm. (17 mg./cm.[2]). A spacing of over 1 cm. was found to give a convenient ion current and negligible beta current. The plate diameter necessary to fulfill the conditions when 1.3-cm. spacers were used was 34 cm. The final diameter used was only 21 cm. Because few particles reach the maximum range, the error introduced should be negligible. As a check, the experiment was carried out using quartz spacers, 0.300 cm. thick. Here no loss of particles would be expected to occur, since a chamber diameter of only 8.5 cm. is theoretically sufficient to include all the beta particles leaving the 17 mg./cm.[2] absorber. The ionization per cm. spacing was found to be the same as for the larger spacers, proving that the error involved by the use of a diameter of 21 cm. was negligible.

The ion current in the gap was measured in amperes and converted to ions per second using the charge per ion as 1.602×10^{-19} coulombs. Energy loss in the gas was found, assuming that the average energy to form an ion pair in air was 32.5 $\pm$ 0.5 electron volts (6).

The energy loss in the air gap is not the same as if the air were replaced by absorber material. The conversion may be made knowing the relative stopping powers of the absorber material and air. Bethe (2) has done a quantum mechanical analysis of the problem and, though the result is difficult to interpret for different atoms, we can say, at least to within 2 per cent, that in the range from 0.05 to 1 mev, the beta particle flux which loses 83 ergs per gram in air (=1 r) will lose 90.5 ergs per gram in cellulose acetate and 94 ergs per gram in wet tissue.

Construction of the Chamber: The plates of the chamber were made 10 inches square with aquadag covering a circular area 8 1/4 inches in diameter, to form the conducting plates of the chamber. The bottom plate was of 3/4-inch arborite[3] which had been moulded between plate glass, and the top plate was 1/4-inch plate glass. Both

[3] Trade name.

surfaces were shown to be flat within better than ±0.0003 inch. A hole 4 cm. in diameter was cut in the plate glass to allow insertion of the absorbers. The absorbers were mounted on polystyrene rings which rested in the hole so that the face of the absorber was even with and formed part of the upper plate of the chamber. The surface of the absorber was covered with aquadag to make it conducting, and care was taken to have electrical contact between the aquadag on the absorber and on the glass.

The plates were separated by means of three accurately cut spacers of good insulating material. A grounded ring of aquadag on the high-voltage plate (glass) around the position of each spacer prevented the high voltage from appearing across the spacers. The whole chamber was supported on three insulating polystyrene blocks inside a steel box 3 inches deep and measuring 14 × 17 inches.

Electrical connections were made to the plates by cementing metal strips on to them. "Conducting Bostick" (Bostick rubber cement with 6.7 per cent Shawinigan Black) was used to fasten the metal and connection to the Bostick cement made with aquadag.

Most of the absorbers were of cellulose acetate because it was readily available in a variety of thicknesses, and was sufficiently rigid that an absorber 4 cm. in diameter and 17.0 mg./cm.^{2} thick would not sag appreciably. Two absorbers were made of polystyrene, so that we might observe the effect of a different absorbing material. There was no deviation from the curve with the cellulose acetate absorbers. The weight of the aquadag applied to the absorbers was considered in obtaining their thickness in mg./cm.^{2}. The absorbers used are listed in the accompanying table (Table I).

Each absorber had to be made to fit flush with the surface of the glass plate. This was done by cutting a number of identical polystyrene rings with a supporting lip, and of such a thickness that when they were placed in the hole the bottom of the ring would be flush with the surface of the glass plate. A circular absorber was cemented to the bottom of the polystyrene ring and a ring cut adjacent to the circular absorber cemented to the supporting lip of the ring (Fig. 4). An identical fit was thus assured for each absorber.

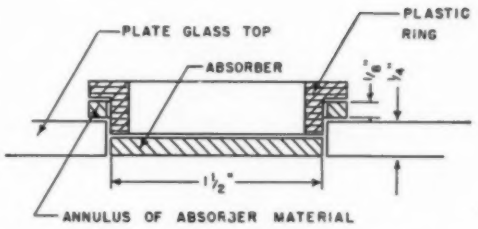

Fig. 4. To make the absorber coplanar with the bottom surface of the glass plate, the circular absorber was cemented to the bottom of the plastic ring and an annulus surrounding the circular absorber was cemented to the supporting lip of the ring.

TABLE I: ABSORBERS

Thickness, mg./cm.^{2} (Aquadag Included)	Material
17.0	Cellulose acetate
49.3	Cellulose acetate
77.2	Cellulose acetate
89.1	Cellulose acetate
110.7	Polystyrene
136.6	Cellulose acetate
263.4	Cellulose acetate
295.7	Cellulose acetate
363	Polystyrene

The three spacers were cut from 1/4-inch polystyrene rod. They were bound together and were ground to a common length of 1.278 ± 0.003 cm. Their resistance was increased by dipping them for a few seconds in a mixture of benzine and alcohol.

The ion currents were determined by measuring the voltage drop across a high resistance. A schematic diagram of the electrical circuit is shown in Figure 5. It was a null method with a Cenco-Dershem electrometer as the null indicating device. When the voltage, V, was equal but opposite in sign to the voltage drop in the high resistance, the collecting electrode was at ground potential so the electrometer showed no deflection. The high resistance was measured accurately for

each set of readings by using a leakage method. Currents ranged from 5×10^{-12} amperes to 2×10^{-9} amperes with the 5.4 mc. applicator.

Measurement of the Total Energy Output: The applicator was clamped in a holder which rested on the glass plate of the chamber. The height of the emitting surface could be varied and thus the surface placed in contact with each absorber.

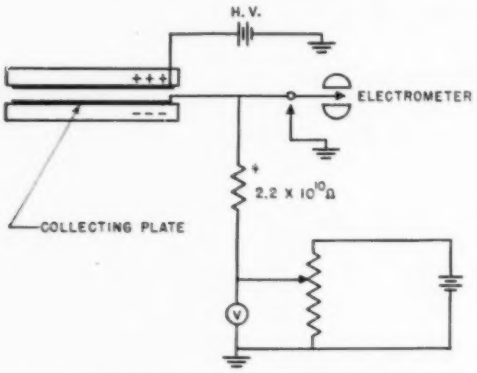

Fig. 5. Schematic diagram of the electrical circuit used with the ionization chamber to measure the ionization currents produced by the beta radiation.

Two series of measurements were made of the nulling voltage for each of the absorbers: one collecting positive ions, and another with the high voltage reversed so that negative ions were collected. The average current per centimeter of plate separation for each absorber thickness is plotted in Figure 6. It is seen to be a straight line indicating exponential absorption for the energy across an infinite plane. This makes it possible to fit a curve to the points and integrate it to get the total energy.

This empirical curve is of the form $i = i_0 e^{-\mu x}$ where x is the thickness of absorber, i is the current, i_0 and μ are constants. By extrapolation to zero absorber thickness, $i_0 = 22.8 \pm 1 \times 10^{10}$ amps. From the slope of the curve, $\mu = 0.01757$ per mg./cm.^{2} of cellulose acetate.

The current readings may be converted to energy dissipation in ergs per sec. per mg./cm.^{2} of cellulose acetate at the depth x by

$$\left(\frac{dE}{dx}\right)_x = \frac{wi}{e}\left(\frac{90.5}{83.0}\right)\frac{1.602 \times 10^{-12}}{d \times 10^3}$$

w = the energy per ion pair which is 32.5 electron volts
e = the electronic charge
= 1.602×10^{-19} coulombs
d = the density of air in gm./cm.^{2} at the time of measurement

The factor to convert from electron volts to ergs is 1.602×10^{-12}. The factor 90.5/83.0 corrects for the relative stopping power of cellulose acetate and air. Inserting these values gives

$$\left(\frac{dE}{dx}\right)_x = 3.54 \times 10^5 \frac{i}{d}.$$

The total energy is then

$$\int_0^\infty \left(\frac{dE}{dx}\right)_x dx = \frac{3.54 \times 10^5}{d} \int_0^\infty i\, dx$$

Carrying out the integration either numerically or graphically, the total energy was shown to be 38.9 ergs/sec.

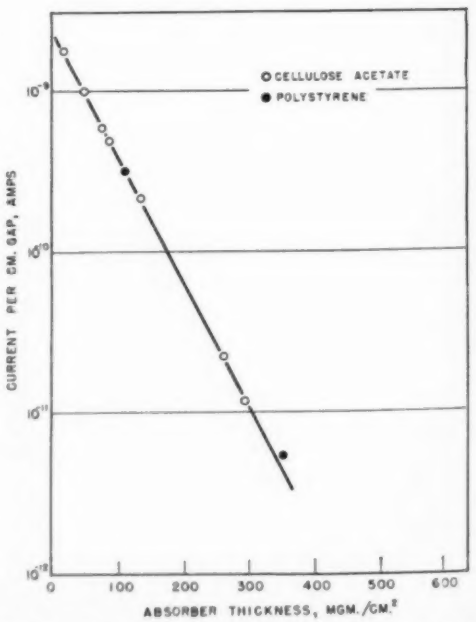

Fig. 6. Absorption of the energy output from a beta applicator.

B. ISODOSE CURVES

To obtain isodose curves for the applicator, autoradiographs were taken by placing an absorber on the film, then putting the applicator in contact with the absorber. The blackening of the film showed the distribution of the energy loss by the beta-

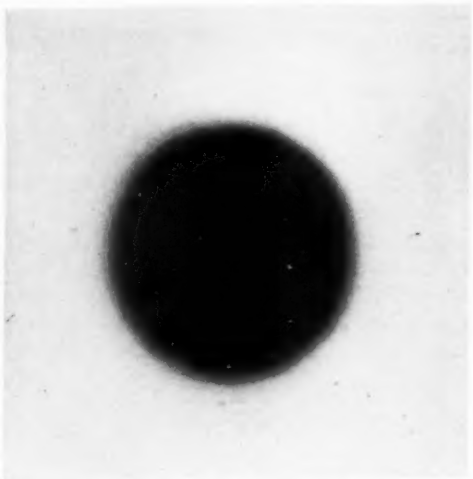

Fig. 7. Autoradiogram of a Ra-E ophthalmic applicator; diameter of active area, 5.6 mm.

rays as they emerged from that absorber.

Anstee (1) made a study of the type of film most suited to high intensity beta radiation. On the basis of his work, Kodalith film developed for five minutes in D23 was used for all our exposures. The relation between density and exposure was linear at least up to a density of 1.7.

Theoretical Discussion

From the ion chamber results, the total energy being lost in an infinite layer at any depth was obtained. The distribution of this energy was shown by an autoradiograph as illustrated in Figure 7 and from this information the absolute value of the energy at any point was derived.

If we let the exposure time be t seconds and energy dissipation at a particular point be J ergs/sec. per mg./cm.^{2}, then using polar coordinates with the origin on the

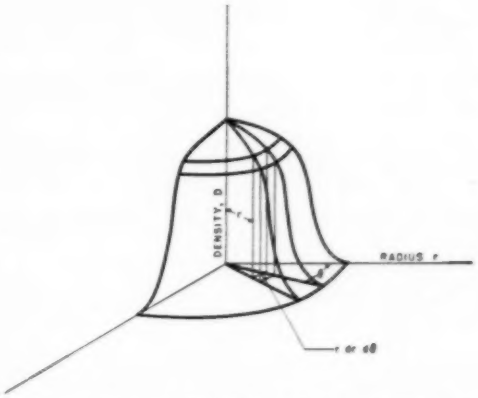

Fig. 8. Diagram illustrating the use of polar coordinates in the calculation of the total energy being lost at any depth.

center line of the applicator, J is a function of r and θ, and the density at the point (r, θ) is

$$D(r,\theta) = \frac{1}{c} J(r,\theta)t$$

where c is a proportionality constant.

In an element of volume of unit thickness at the depth x and point (r, θ), the energy absorbed per second is

$$J(r, \theta, x) = \frac{c}{t} D(r\,\theta) r\, dr\, d\theta. \quad \text{(Fig. 8)}$$

The total energy being lost at that depth is

$$\left(\frac{dE}{dx}\right)_x = \frac{c}{t} \int_r \int_\theta D(r,\theta) r\, dr\, d\theta.$$

The constant c is chosen to fit this equation using the value of $\left(\frac{dE}{dx}\right)_x$ as measured with the ionization chamber. For any particular exposure, t is a measured constant. If the distribution of the activity is symmetrical about the center of the applicator, D is a function only of r. Then we can integrate with respect to θ and write

$$\left(\frac{dE}{dx}\right)_x = \frac{2\pi c}{t} \int_0^\infty r D(r)\, dr.$$

Development of Dose Data

In practice, $D(r)$ was found by taking a microphotometer trace across the radio-

gram from effectively $r = -\infty$ to $r = \infty$. The integral

$$\int_{-\infty}^{\infty} rD(r)\,dr$$

was evaluated by drawing the graph of $r\,D(r)$ and finding the area under the curve with a planimeter. Six exposures per sec. corresponding to the calculated value of 40 ergs per sec. The surface dose rate with the applicator in contact with tissue was 1,740 ± 150 rep per minute at the center, dropping to half this value at the edge.

Isodose curves showed that at a depth of 1.0 mm. of tissue, the dose rate had

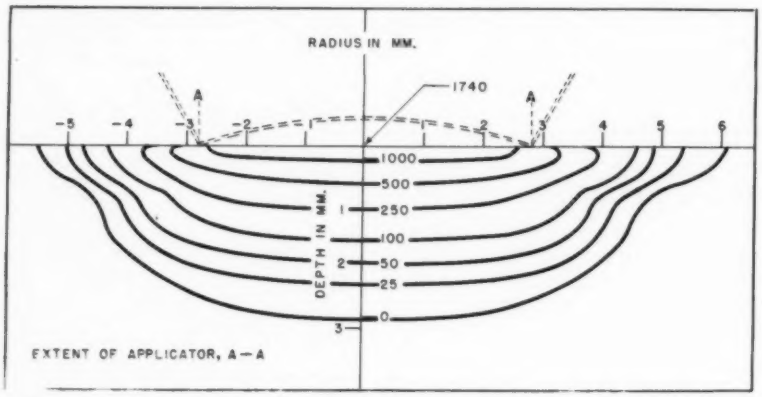

Fig. 9. Isodose curves at various depths in tissue. Dose rate in rep per minute.

on the same film gave the mean value of c to be 36,700 ergs per sec. per gm./cm.^{2} with a standard deviation of 2 per cent. This mean value, $\bar{c}$, was used to determine the dose rate at any point as given by

$$J(r) = \frac{\bar{c}}{t} D(r).$$

Table II shows the calculation of the dose rate at the center line after several absorbers.

Because of the higher stopping power of tissue, the surface dose is higher than the cellulose acetate dose rate by a factor of 94/90.5. The absorption coefficient is increased by a corresponding amount. Table II also gives the depth of unit density tissue which corresponds to each absorber thickness of cellulose acetate.

Figure 9 shows isodose curves plotted from data similar to those in Table II.

CONCLUSIONS

The total energy output of an applicator was measured with an infinite plane cavity ion chamber and found to be 39 ± 3 ergs dropped to almost 10 per cent of the surface dose rate, and at 3 mm. was about 0.25 per cent of the surface value. Almost 90 per cent of the energy was lost in the first millimeter and 99.25 per cent by the end of the third.

It was found empirically that, for this applicator, the dose rate integrated over each plane followed an exponential absorption curve, with a half-value layer of 39.5 mg./cm.^{2}. If the value of the intensity at the center was used to plot the absorption curve, the initial drop was steep, reducing to half the intensity after 25 mg./cm.^{2}, but after about 75 mg./cm.^{2} the slope became less and gave a half-value layer of 39.5 mg./cm.^{2}.

The apparatus described may be used to measure an applicator of any size and for beta energies above about 0.2 mev. The low energy limit is set by the thinnest absorbers which may be obtained, and by improved technics in constructing absorbers this limit could be reduced. It would be possible to measure the output of sources as small as 10 microcuries and

TABLE II: DOSE RATE DATA AT THE CENTER LINE

Absorber Thickness (mg./cm.²)	Exposure ((t) in seconds)	Density (D) at Center Line	$\bar{e}$ / t D Energy Loss (ergs/sec./gm.) Cellulose Acetate	Equivalent Tissue Depth (mm.)	Tissue Dose Rate (rep/min.)
0	10	0.6306	2,314	0	1,737
17.6	40	1.591	1,460	0.169	1,096
50.4	90	1.780	726	0.484	545
89.7	140	1.597	419	0.861	314
137.2	360	1.734	177	1.317	133
264	1,920	0.909	17.4	2.53	13

as large as 100 millicuries or more with few changes in the apparatus.

The present arrangement is adaptable only to flat or to concave radiating surfaces, but the principle could be applied to a source of almost any shape. For instance, a cylindrical chamber with cylindrical absorbers could be used for beta-emitting needles.

ACKNOWLEDGMENTS: Thanks are extended to Eldorado Mining and Refining (1944) Ltd. for pointing out the necessity for this work, and for the loan of the ophthalmic applicator SP-9 upon which all measurements for this report were made. Use of their data on films simplified our work and their measurements of activity made the theoretical checks possible. The continued interest of Dr. A. Morrison of this laboratory and his many helpful discussions have been fully appreciated.

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SUMARIO

Medición de los Aplicadores de Rayos Beta

La calibración de los aplicadores de rayos beta para oftalmología, por medio de su índice de dosis superficial, entraña ciertas limitaciones que aparentemente se evitan calibrando a base de la producción de energía.

Usando una delgada cámara de yones en placas paralelas, de extensión en efecto ilimitada, se ha elaborado una técnica para determinar la energía total de los aplicadores de rayos beta. La cámara fué utilizada con una serie de absorbentes para medir la energía total de las partículas beta procedentes de un aplicador oftálmico de radio D + E. Una comparación de las mediciones de la cámara de yones con las autorradiografías suministró la distribución de la pérdida de energía, trazándose después las curvas de isodosis.

Las curvas de isodosis revelaron que, a una profundidad de 1 mm. de tejido, la dosis había bajado a casi 10 por ciento de la dosis superficial, y a 3 mm. representaba aproximadamente 0.25 por ciento de la cifra de la superficie.

Puede usarse el aparato para medir aplicadores de cualquier tamaño y para valores beta superiores a unos 0.2 mev. La instalación actual sólo se presta para superficies de radiación planas o cóncavas, pero el principio mismo es aplicable a focos de casi todas las formas.

EDITORIAL

Radiology and the Related Sciences

Radiology as we think of it today is dominantly a medical field, in which the major objectives are the diagnosis and treatment of disease, and properly so. But like many other fields, including medicine in general, its growth and development depend to a considerable extent upon advances in other sciences and hence upon close interrelationship with them. In its first days, before it could even lay claim to a title all its own, radiology was practised by photographers, engineers, and physicists. In fact, the name of an engineer—Silvanus Thompson—is one of the best known in early British radiology. The name of physicist W. D. Coolidge is almost synonymous with radiology the world over, not only because of his invention of the hot cathode x-ray tube but because of his continuing contributions to the radiological field.

As radiology began to mature in the early twenties, it found itself in possession of the tools to perform deep therapy on a reliable day-to-day basis—reliable, that is, to the extent that the x-ray equipment could be counted upon to perform its duty without the tantrums and tempers of the earlier gas tubes. This brought with it the necessity for strict dosage control, an understanding of depth dose, and the concept of radiation dosage units which it was hoped would apply under all irradiation conditions. Then entered the physicist to work with the radiologist in a borderline field beyond the ken of all but a very few medical radiologists. This partnership has prospered to the material benefit of both radiology and physics.

Physicists have become associate members of our radiological societies; they have served on our technical committees relating to x-ray units, standards, and protection; they are members of the team in an increasing number of radiological departments and institutions, and they are now certified as Radiological Physicists by the American Board of Radiology—the outgrowth of a movement started in 1935 by the Standardization Committees of the radiological societies of this country. The closeness of the bond between these two sciences has increased steadily, if for no other reason than the fact that with advances in physics and engineering, the technics of radiology have become almost too complicated for the radiologist to attempt to handle alone. All this was true prior to the advent of the atomic energy era; the same situation now exists on a greatly magnified scale. In addition, this new development has given accent to other borderline fields—always important and so recognized, but now sought after as a part of the family Radiology. With the new tools of radioactive isotopes for research, therapy, and diagnosis, the radiobiologist, the radiochemist, the radiophysicist, and to a great extent the surgeon and internist using isotopes must be brought closer together with the radiologist for the accomplishment of their common aim.

The Radiological Society of North America has always been aware of the necessity for this closer relationship between the scientists of borderline or associated fields and its radiologist members. It now recognizes that this union of interests must develop on a broader scale and that to accomplish this, the workers in the various fields must have a common meeting ground. The ideal medium for the union would appear to be the annual scientific meeting of the Society.

At the annual meeting which will be held

in Cincinnati in December of this year, the Radiological Society of North America is expanding its program facilities to include the presentation of a much larger number of scientific papers and discussions in the borderline sciences. In addition to the usual sessions on more purely medical radiology, there will be held each morning, Tuesday through Friday, parallel scientific sessions devoted primarily, and about equally, to subjects in radiophysics, radiobiology, and radiochemistry. The single afternoon sessions will include borderline science reports which are of a more general and less technical nature. It is expected that the time limitations will permit the reading of at least sixteen papers in the parallel morning sessions.

In addition, the Refresher Course program will be expanded to allow the presentation of twelve lectures or demonstrations. This will mean the addition of about eight new courses which have never before been given, together with the four which have been given yearly in the past.

It is hoped that with these expanded program facilities, many of our scientists in associated fields will find the coming annual meeting of the Radiological Society of North America a fruitful ground for the discussion of their ideas and problems. Here they should better learn the needs of the radiologist and at the same time let the radiologist learn of their fields Only by this means can we realize the ultimate benefit from all of our complex scientific aids.

LAURISTON S. TAYLOR, PH.D.

RADIOLOGICAL SOCIETY OF HAWAII

The Radiological Society of Hawaii was organized on March 14, 1952, and meetings were scheduled for the third Friday of each month, at Tripler Army Hospital, Honolulu. Col. Alexander O. Haff, Tripler Army Hospital, is secretary of the new society and Dr. Philip S. Arthur is treasurer.

SECOND INTERNATIONAL COURSE IN STRATIGRAPHY

The Second International Course in Stratigraphy, of which a preliminary announcement appeared in the February issue of RADIOLOGY, will be held in Genoa, Italy, Sept. 1–10, 1952, under the direction of Prof. Alessandro Vallebona.

The first part of the course (Sept. 1–3) is set apart for persons who did not attend the original course in 1950, which covered the general procedure. The remainder of the time will be devoted especially to the newer, improved method.

The cost of the complete course is L.5000; of the second part (Sept. 4–10) L.3500. Fees should be sent, with applications for the course, by May 30, to Dr. Alessandro Piazza, Istituto di Radiologia dell' Università di Genova, Ospedale San Martino, Genova, Italy.

DAVID ANDERSON-BERRY PRIZE

A David Anderson-Berry silver-gilt medal, together with a sum of money amounting to about £100, will be awarded in 1953 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the therapeutic effect of x-rays on human diseases.

Applications for this prize, accompanied by copies of relevant papers, should be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, Scotland, by March 31, 1953.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

DIAGNOSTIC AND EXPERIMENTAL METHODS IN TUBERCULOSIS (Second Edition). By HENRY STUART WILLIS, M.A., M.D., F.A.C.P., Superintendent and Medical Director, North Carolina Sanatoria, McCain, N. C.; Consultant, U. S. Public Health Service; Formerly, Associate in Medicine, The Johns Hopkins University, and Visiting Physician, The Johns Hopkins Hospital, Baltimore, Md.; Formerly, Superintendent and Medical Director, Maybury Sanatorium, Northville, Mich.; and MARTIN MARC CUMMINGS, M.D., F.C.C.P., Director, Tuberculosis Research Laboratory, Lawson Veterans Administration Hospital, Veterans Administration, Chamblee, Ga.; Instructor in Medicine, Emory University School of Medicine, Atlanta, Ga.; Consultant, U. S. Public Health Service; Formerly, Director, Tuberculosis Evaluation Laboratory, Communicable Disease Center, United States Public Health Service, Atlanta, Ga. A volume of 374 pages, with 40 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $10.00.

LEHRBUCH DER RÖNTGENDIAGNOSTIK. By H. R. SCHINZ, W. E BAENSCH, E. FRIEDL, E. UEHLINGER, with contributions by E. BRANDENBERGER, A. BRUNNER, U. COCCHI, N. P. G. EDLING, J. EGGERT, F. K. FISCHER, M. HOLZMANN, H. KRAYDENBÜHL, Å. LINDBOM, E. LINDGREN, G. A. PREISS, S. WELIN, and A. ZUPPINGER. 6. Lieferung. Innere Organe. A volume of 544 pages, with 507 illustrations. Published by Georg Thieme, Stuttgart, 5th completely revised edition, 1952. Distributors for the U.S.A. and Canada: Grune & Stratton, Inc., New York, N. Y.

GESCHWÜLSTE DES OHRES UND DES KLEINHIRNBRÜCKENWINKELS. By DR. MED. K. GRAF, Priv.-Doz. für Ohren-Nasen-Halsheilkunde an der Universität Zürich. A monograph of 284 pages, with 132 illustrations. Published by Georg Thieme, Stuttgart, Germany, 1952. Distributors for U. S. A. and Canada: Grune & Stratton, Inc., New York, N. Y.

GRUNDLAGEN DER STRAHLENTHERAPIE: PHYSIK, BIOLOGIE UND ALLGEMEINE THERAPIE. By Dr. Med. RICHARD KURT KEPP, Apl. Professor für Gebürtshilfe und Frauenheilkunde an der Universitäts-Frauenklinik, Göttingen. With 134 illustrations. Published by Georg Thieme, Stuttgart, Germany, 1952. Distributors for U. S. A. and Canada: Grune & Stratton, Inc., New York, N. Y.

Book Reviews

THE SKULL AND BRAIN ROENTGENOLOGICALLY CONSIDERED. By C. WADSWORTH SCHWARTZ, Ph.B., M.D., F.A.C.R., Associate Professor of Clinical Radiology, College of Physicians and Surgeons, Columbia University; Associate Clinical Profes-

sor of Radiology, College of Medicine, New York University; One-Time Director of Radiology, Neurological Institute of New York; Consultant to Presbyterian Hospital of New York, Hospital for Special Surgery of New York, New York City Hospital (Neurological Division); Associate Attending Radiologist, University Hospital, New York City, Mt. Vernon Hospital, Mt. Vernon, N. Y.; Attending Radiologist, St. Agnes Hospital, White Plains, N. Y., and LOIS COWAN COLLINS, B.S., M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Assistant Radiologist, Presbyterian Hospital, New York City; Associate Radiologist, New York Psychiatric Institute; Consultant, U. S. Marine Hospital, Staten Island, N. Y. A volume of 386 pages, with 335 figures, Published by Charles C Thomas, Springfield, Ill., 1951. Price $10.50.

The authors have not attempted to produce an exhaustive volume on roentgenology of the skull and brain. What they have succeeded in doing is to collect in one volume typical illustrations of the more common lesions of the skull and brain which present themselves to the radiologist in his practice. This method of procedure they justify with the argument that the unusual case, being simply a variant of the typical case, always possesses in some degree the characteristics of the latter. Hence, a clear understanding of the usual findings enables one to comprehend the borderline lesion. The goal thus set has been attained in an admirable fashion through fine illustrations and a clear, precise text.

A brief discussion of technic and considerations of the normal skull precedes chapters on congenital anomalies, traumatic disorders, tumors, infectious diseases, and a final group of miscellaneous diseases not covered elsewhere in the book. Lesions of the skull itself, the brain substance, the meninges, and the blood vessels are considered. Enough clinical and pathological data are given to complete the general picture of each entity discussed. Reference lists are provided at the end of each chapter.

ANGIOCARDIOGRAPHY. ANNALS OF ROENTGENOLOGY, Vol. XX. By CHARLES T. DOTTER, M.D., Assistant Professor of Radiology, Cornell University Medical College; Assistant Attending Radiologist, The New York Hospital, and ISRAEL STEINBERG, M.D., Assistant Clinical Professor of Radiology and Medicine, Cornell University Medical College; Assistant Attending Radiologist and Physician to Outpatients, the New York Hospital; Attending Physician and Chief of Chest Clinic, Sydenham Hospital; Attending Consultant, Chest Diseases, V. A. Hospital, Bronx; Consultant in Angiocardiography, U.S.N.H., St. Albans, N. Y. A volume of 304 pages, with 635 illustrations. Published by Paul B. Hoeber, Inc., New York, 1951. Price $16.00

In Volume XX in the Annals of Roentgenology series, a treatise on Angiocardiography, Dr. Charles T. Dotter and Dr. Israel Steinberg have organized their material in such a way as to give a comprehensive introduction to this relatively new procedure, affording a practical guide to the technical details and interpretation of the films.

The technic of the examination is fully described, including chapters on apparatus and contrast media. Following a full account of the normal angiocardiogram are chapters on acquired and congenital heart disease, tumors of the mediastinum and lung and their effect on the angiocardiogram, and, finally, pulmonary diseases other than tumors.

Emphasis is fairly divided between the applications of the procedure and its limitations. In the opinion of the reviewer, it would have been desirable to have included more illustrations of atypical congenital heart lesions. This, however, is the only deficiency in an otherwise fine textbook. The reproductions of angiocardiograms are of the highest quality, each being accompanied by a schematic tracing which clarifies the points discussed in the text. The bibliography is comprehensive and up to date.

PATHOLOGY OF THE FETUS AND THE NEWBORN. By EDITH L. POTTER, M.D., Ph.D., Associate Professor of Pathology, Department of Obstetrics and Gynecology, The University of Chicago; Pathologist, The Chicago Lying-in Hospital; Chief Pathologist, Chicago Department of Health. A volume of 574 pages, with 601 illustrations. Published by the Year Book Publishers, Inc., Chicago, 1952. Price $19.00.

The author of this volume devoted to the intrauterine development of the fetus and its later adaptation to its new environment is a pathologist with a clinical outlook. In a particularly excellent preface she writes: "Only if this work ultimately helps save the lives of infants who otherwise might die will it have been worth the effort expended in its production."

The work is a reflection of eighteen years of interest and study and of observations on a huge material. This includes over 6,000 autopsies performed at the Chicago Lying-in Hospital as well as the examination of tissues and protocols from many thousands of autopsies performed on infants in other institutions.

The radiologist will be especially interested in the many malformations which are described and illustrated. It is seldom that such a variety of rare and interesting fetal abnormalities are collected in one volume. Description of the development of normal organs and deviations therefrom are given in chapters devoted to the various parts of the body. Disease processes which may be considered as in the class of congenital lesions are also described. In fact, no significant lesions occurring in infants under a year appear to be overlooked.

The volume is attractively printed and bound. The illustrations are well chosen, and the reproductions are good. There is a representative bibliography at the end of each chapter. An excellent feature of the index is the inclusion of references to the illustrations as well as the text. This book cannot fail to appeal to anyone interested in the pathology of the fetus and newborn.

ROENTGENOLOGIC DIAGNOSIS OF DISEASES OF BONES. By DAVID G. PUGH, Assistant Professor of Radiology, Mayo Foundation, Graduate School, University of Minnesota; Consultant, Section on Roentgenology, the Mayo Clinic. A volume of 316 pages, with 296 illustrations. Reprinted from Nelson's Loose-Leaf Diagnostic Roentgenology. Published by Thomas Nelson & Sons, New York, 1951. Price $5.00.

This volume is a reprint of material appearing originally under the same title in Nelson's *Loose-Leaf Diagnostic Roentgenology*, edited by Dr. Ross Golden. It covers most of the skeletal deformities and diseases seen by the roentgenologist, giving brief lucid descriptions of the various abnormalities and disease processes, with emphasis on the basic pathology. Among the conditions discussed in fullest detail are the endocrine diseases affecting bone, bone dystrophies, vitamin deficiencies, fibrous diseases, dysplasias, diseases of the hematopoietic and reticulo-endothelial systems, infections, the arthritides, osteochondrosis and aseptic necrosis, and bone tumors.

In addition to the excellent descriptive material, there are numerous roentgenograms illustrating many of the bone lesions. A short bibliography of representative articles from the literature is given at the end of the text, and an index is included.

This volume is recommended to all desirous of a concise description of the usual bone diseases, particularly to radiologists, students, and orthopedists.

DIE GESUNDE UND KRANKE WIRBELSÄULE IN RÖNTGENBILD UND KLINIK. PATHOLOGISCH-ANATOMISCHE UNTERSUCHUNGEN. By GEH. MED.-RAT PROF. DR. MED. ET DR. MED. VET. H.C. GEORG SCHMORL. Roentgen and clinical aspects revised by PROF. DR. MED. HABIL. HERBERT JUNGHANNS, OLDENBURG (Oldb.). A volume of 282 pages, with 399 illustrations. Second edition, published by Georg Thieme, Stuttgart, 1951. Distributors for U. S. A. and Canada: Grune & Stratton, Inc., New York, N. Y.

This work on the spine rests upon a foundation of pathological and radiological study of tens of thousands of specimens removed at necropsy. Schmorl guided the dissections until his death in 1932—according to tradition having personally inspected 25,000 spines—and since that date Junghanns has taken over. The method of study has yielded x-ray reproductions of unbelievable quality and beauty. The intact spines were dissected free of the soft tissues, bivalved with a saw, and then one of the halves roentgenographed. Both the external and the saw cut surface were photographed, studied in various transverse planes, and finally sectioned for microscopy.

A chapter on the normal growth, development, and anatomy of the spine opens the text. Of interest is the emphasis on the difference between vertebral phylogeny and embryology. The second chapter, dealing with developmental errors of the spinal column, is undoubtedly one of the best extant presentations. Not only are numerous developmental anomalies described, but logical and acceptable explanations for their cause are offered. Under the general grouping of structural disturbances, a large number of miscellaneous ailments are discussed in the third chapter: osteoporosis, osteomalacia, Paget's disease, tuberculosis, metastatic neoplasms, fractures, osteogenesis imperfecta.

The node produced by protrusion of an intervertebral disk into a centrum is immediately associated with the name of Schmorl. Investigations go far beyond this, however, for one fourth of the pages pertain to acquired disease of the disk. Prolapse into the centrum, prolapse posteriorly, chondrosis intervertebralis, osteochondrosis intervertebralis, and disk calcification receive full treatment. Minor disturbances are not ignored. For example, vascularization of the disk, while of little radiologic interest, is well pictured from a gross specimen.

The last four chapters of the eight in the book are less exhaustive than one might expect. Here are found discussions of spondylosis deformans, spondylolisthesis, scoliosis, stiff back, and spondylitis ankylopoietica. The method of study precluded exact analysis of spinal curvatures. It is also to be noted that the authors' concept of adolescent kyphosis differs from that of Scheuermann and Mau.

The coverage of clinical aspects is at best sketchy. This, however, like the use of roentgenograms of prepared specimens, is not too bothersome, since the concern is with fundamentals, not with treatment. A long bibliography is appended, but unfortunately there is no index.

LES SYNDROMES DOULOUREUX DE LA RÉGION ÉPIGASTRIQUE. By RENÉ-A. GUTMANN, Médecin des Hôpitaux de Paris. Volumes 1 and 2, 1,680 pages, 1,271 roentgenograms, and 411 drawings. Published by G. Doin et Cie, Paris, 5th ed, 1951.

Gutmann not only practises as a gastro-enterologist but also has assisted in many operations involving the gastro-intestinal tract. Therefore, he has been directly interested in the general clinical, laboratory, gastroscopic, and radiologic diagnosis of diseases of the digestive system, and has also followed the medical and surgical aspects of treatment. In these volumes on painful syndromes of the epi-

gastric region the method of presentation varies from the discussion of separate entities, such as peptic ulcer, gastric cancer, and others, to chapters on the general management of specific clinical syndromes, such as outlet gastric obstruction, in which the underlying cause may vary.

The late diagnosis of cancer by North American physicians is decried, since the author believes that early diagnosis is possible. Gastroscopic diagnosis and even palpation of the stomach by the surgeon during laparotomy are often found wanting in the early diagnosis of cancer. Careful clinical evaluation and radiological procedures combined with a high index of suspicion are necessary. Careful fluoroscopy in both the upright and horizontal positions, with carefully aimed spot films in various projections, is stressed.

Pharmacoradiology is discussed and mentioned frequently in the text. This consists of an attempt to enhance the demonstration of various lesions by combining the administration of drugs with the radiologic examination. By administering 10 mg. of morphine sulfate or 5 to 10 units of insulin hypodermically, gastric peristalsis is enhanced and demonstration of small lesions, both benign and malignant, near the gastric outlet and in the duodenum becomes more exact. In stenosing lesions of the gastric outlet presenting with gastric retention, an emetic dose of syrup of ipecac is given to empty the stomach and thus improve gastric tone and peristalsis for radiologic examination.

Much of the text is concerned with clinical matters, including therapeutic procedures, both medical and surgical, which are covered as adequately in the English literature. For those qualified in reading French, however, it is interesting to compare thoughts concerning the ever-stimulating subject of problems presented by the patient with epigastric pain.

THE 1951 YEAR BOOK OF RADIOLOGY (JUNE, 1950–JUNE, 1951). RADIOLOGIC DIAGNOSIS, edited by FRED JENNER HODGES, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan, and JOHN FLOYD HOLT, M.D., Associate Professor, Department of Roentgenology, University of Michigan. RADIATION THERAPY, edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and VINCENT P. COLLINS, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director, Department of Radiation Therapy, Francis Delafield Hospital; Attending Radiologist, Presbyterian Hospital, New York City. A volume of 394 pages, with 368 illustrations. Published by the Year Book Publishers, Chicago 11, Ill., 1951. Price $7.00.

For two decades the Year Book Publishers have been issuing their annual review of the radiologic literature, covering not only the newer and more striking developments in this field but following also the less dramatic but steady progress in the application of accepted procedures in roentgen diagnosis and radiotherapy. The present volume brings this review up to the middle of 1951.

The plan of the work is the same as in earlier years, about two-thirds of the space being devoted to radiologic diagnosis and the remainder to therapy. Dr. Harold W. Jacox and Dr. Vincent P. Collins of the College of Physicians and Surgeons of Columbia University replace Dr. Isadore Lampe and Dr. Robert S. MacIntyre of the University of Michigan as editors of the latter section. The choice of these new editors from one of the great eastern medical centers insures a maintenance of the high standards set by their predecessors.

Both the diagnostic and therapy sections open with introductions indicating the general trends for the period covered. Dr. Hodges and Dr. Holt give special attention to the Sixth International Congress of Radiology held in London in July 1950.

Roentgen methods for the demonstration of the circulatory system—angiography, arteriography, angiocardiography, and aortography—claim an increasing amount of space, and there continues to be a laudable interest in radiation hazards and protective measures. The borderline or associated fields of radiobiology and radiophysics are given their share of attention, more especially in their clinical applications.

The American radiological journals are well covered and there is a generous admixture of articles of radiological interest from other specialty and regional periodicals. Coverage of the foreign literature unfortunately—perhaps unavoidably—is less complete, but most of the important radiological publications are represented.

The binding of the volume matches that of the preceding year. The illustrations and general make-up are, as in earlier volumes, excellent.

IN MEMORIAM

LEO M. LEVI, M.D.

1901-1951

Leo M. Levi, Radiation Therapist at the Los Angeles County Hospital, Assistant Professor of Radiology, School of Medicine, University of Southern California, and Clinical Professor of Radiology, College of Medical Evangelists, died at the Hospital of the Good Samaritan, Los Angeles, on Dec. 25, 1951. Dr. Levi was born in Zanesville, Ohio, in 1901, secured his Bachelor of Arts degree at Ohio State University in 1923, and was graduated from Jefferson Medical College in 1927. He served an internship at St. Agnes Hospital, Philadelphia, and practised in Zanesville for three years. Following a year of postgraduate work in surgery in Budapest and Vienna, he was a resident in tumor surgery at the Los Angeles County Hospital in 1933–35. Moving into the field of radiation therapy as resident at the Cedars of Lebanon, 1935–36, he joined Seeley Mudd and Charles Lauritsen at the California Institute of Technology for two years in the first clinical application of million-volt x-radiation. His sound judgment and careful observations, both in the treatment and follow-up of patients, were integral factors in the prosecution of this initial effort in the use of high-energy radiation in cancer. In 1938 Dr. Levi assumed direction of Radiation Therapy at the Los Angeles County Hospital, a post to which he lent distinction until his retirement in 1950. His surgical background, along with an unusual experience in radiotherapy, an encyclopedic knowledge of oncologic literature, and his humanitarianism, made him a rare combination of sympathetic physician and astute therapist. His contributions to the medical literature included a variety of technics and methodology in the treatment of various forms of cancer, as well as studies of end-results and observations on the natural history of certain neoplasms.

A man of great charm and of irrepressible wit, Dr. Levi was a purist in the use of English, impeccable in its pronunciation, a master of the verbal riposte, a raconteur of the highest ability. A man of many parts, he had been in his earlier days a professional magician, maintaining a lively interest in this occult art throughout his life, attending as many magicians' conventions as medical meetings. He was a collector of Orientalia and of ancient edged weapons, which seemed to many of his friends an unlikely interest for one devoid of any but verbal violence. With associates and social equals he was not incapable of acidulous and even scathing commentary; with the sick he was invariably gentle, sympathetic, and inspiring. His most rewarding experience was his almost daily contact with cancer patients successfully treated during his years at the County Hospital, and the respect and admiration of those under his care was a memorable feature of his professional life.

By his associates on the Cancer Service and Tumor Board of the Los Angeles County Hospital, Dr. Levi will be long remembered for his judicial evaluation of therapeutic methods in cancer. During his early years at the Hospital he contributed a sense of perspective and balance in the selection of surgical and radiation methods. His was the most important single influence in establishing a rational clinical attitude toward the treatment of cancer.

Dr. Levi was certified in Therapeutic Radiology by the American Board of Radiology in 1938. His affiliations included: The American College of Radiology, American Radium Society, Radiological Society of North America, American Medical Association, Pacific Roentgen Ray Society, California Medical Association, Radiological Section of the Los Angeles County Medical Society, American Association for Advancement of Science, American Association of University Professors, and Sigma Xi Research Society.

IAN MACDONALD, M.D.
Los Angeles, Calif.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 507 Professional Bldg., Phoenix. Annual meeting with State Medical Association.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, John B. Hamilton, M.D., 210 N. Central Ave., Glendale 3. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, G. A. Fricker, Sacramento Co. Hospital, Sacramento 17. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association Convention.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Rex Uncapher, M.D., 7720 Girard Ave., La Jolla. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly, at the University Club.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Ford Shepherd, M.D., 526 Soquel Ave., Santa Cruz. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Charles E. Duisenberg, M.D., Palo Alto Clinic, 300 Homer Ave., Palo Alto. Meets third Thursday at 7:45, January to June at Stanford University Hospital, July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wendell P. Stampfli, M.D., 1933 Pearl St., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Fred Zaff, M.D., 135 Whitney Ave., New Haven. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Nelson T. Pearson, M.D., 1109 Huntington Bldg., Miami. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, Maurice Greenfield, M.D., Ingraham Bldg., Miami. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Dudley King, M.D., 35 Linden Ave., N. E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert C. Pendergrass, M.D., Americus. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, Col. Alexander O. Haff, Tripler Army Hospital, Honolulu. Meets monthly on the third Friday, at Tripler Army Hospital.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Benjamin D. Braun, M.D., 6 N. Michigan Ave., Chicago 11. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Willard C. Smullen, M.D., St. Mary's Hospital, Decatur.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, James N. Collins, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Charles M. White, M.D., 3244 East Douglas, Wichita 8. Meets annually with State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M. D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Clark F. Miller, M.D., Central Maine General Hospital, Lewiston. Meets three times a year—Spring, Summer, and Fall.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, Richard B. Hanchett, M.D., 705-6, Medical Arts Bldg., Baltimore 1. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, Leo A. Nash, M.D., 572 Lowry Medical Arts Bldg., St. Paul 2. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 621 High St., Jackson 2, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Sidney Rubin, M.D., 410 Professional Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Francis O. Trotter, Jr., M.D., 634 North Grand Blvd., St. Louis 3. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Russell W. Blanchard, M.D., 1216 Medical Arts Bldg., Omaha. Meets fourth Thursday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, L. L. Robbins, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 8:45 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Joseph J. La Vine, M.D., 259 North Grand Avenue, Baldwin, N.Y. Meets second Tuesday, February, April, June, October and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Irving Schwartz, M.D., 45 E. 66th St., New York 21.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets at University Club, Albany, second Wednesday, October, November, and March. Annual meeting in June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, George Gamsu, M.D., 191 S. Goodman St. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Walter J. Brown, M.D., Northern Westchester Hospital, Mount Kisco, N. Y. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, P. H. Woutat, M.D., 221 S. 4th St., Grand Forks.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 1838 Parkwood Ave., Toledo 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Lee S. Rosenberg, M.D., Jewish Hospital, Cincinnati 29. Meets first Monday, October through May.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Geo. A. Nicoll, M.D., Miami Valley Hospital, Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Edwin J. Euphrat, M.D., 3500 Fifth Ave., Pittsburgh 13. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr. Next annual meeting Aug. 7–9, 1952, in Denver.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Henry E. Plenge, M.D., 855 N. Church St., Spartanburg. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, John E. Whiteleather, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Jan. 23–24, 1953, San Antonio.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John N. Burkey, M.D., 555 Medical-Dental Bldg., Seattle. Meets fourth Monday, September through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving I. Cowan, M.D., 425 East Wisconsin Ave., Milwaukee 2.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Jean Bouchard, M.D. Assoc. Hon. Secretary-Treasurer, D. L. McRae, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 26, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origène Dufresne, M.D., Institut du Radium Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPÍA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPÍA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, Mexico, D.F. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

PUERTO RICO

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542 Santurce, Puerto Rico.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

Hernia

The Musculoskeletal System

Gynecology and Obstetrics

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

An Experimental Method for the Evaluation of Contrast Media Used in Cerebral Angiography. Byron M. Bloor, Frank R. Wrenn, Jr., and George J. Hayes. J. Neurosurg. **8:** 435–440, July 1951.

Contrast media used for cerebral angiography must not only demonstrate the cerebral vascular tree in an adequate manner, but must also be relatively nontoxic in volumes and concentrations necessary for their primary purpose. The authors have devised a method to study the adverse effects of contrast media used or proposed for cerebral angiography.

Broman has previously demonstrated that diodrast-like substances injected into the carotid artery of animals produce unequivocal changes in the permeability of the cerebral vessels. This he did by the simultaneous injection of diodrast and trypan blue. If the permeability of the vessels was increased, the brain was found to be stained by the dye. He attributed these changes to a chemotoxic influence upon the endothelium of the vessel wall (Broman, Forssman, and Olsson: Acta radiol. **34:** 135–143, 1950. Abst. in Radiology **56:** 901, 1951). The method of study described in the present paper combines the dye indicator technic with concomitant electroencephalography in an effort to obtain evidence of more subtle changes in cerebral physiology, as well as correlative data.

Twenty-nine observations were made on 24 rabbits, using as test substances thorotrast, 35 per cent diodrast, 70 per cent diodrast, 75 per cent neo-iopax, and 30 per cent urokon, all commercially available. In addition, 2,4 dioxo-3 iodo, 6 methyl-tetra-hydropyridine-N acetic acid in 70 per cent solution was used.

Nine of 10 animals with 4+ electroencephalographic changes were found to show brain staining, an indication of altered vascular permeability. In only 1 of 6 animals with 3+ changes did brain staining occur. Vital staining was never observed in animals with 1 and 2+ electroencephalographic alterations.

Three electroencephalograms; 2 tables.

HOWARD L. STEINBACH, M.D.
University of California

Demonstration of the Brain Vessels with Viscous Perabrodil M (35 per cent). K. Albrecht and W. Dressler. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 689–697, June 1951. (In German)

Cerebral angiography contributes useful information in localizing brain lesions, being of special value in vascular disorders. It may be important from the surgical standpoint to differentiate between active and passive brain edema. Active edema is frequently the result of trauma with increased arterial pressure. Passive edema is due to resistance to venous return, often caused by a mass lesion.

Earlier attempts to demonstrate the brain vessels were handicapped by the pain of injection, thrombosis, and embolism. Death occurred in a few cases. Thorotrast, although technically satisfactory, was discarded because of carcinogenic tendencies. Viscous perabrodil M (35 per cent) is a new preparation which has been found quite satisfactory for this type of work.

The authors recommend stellate block prior to angiography, as a means of inducing anesthesia and dilating the vessels, thus avoiding the tendency to spasm. They use 25 to 30 c.c. of viscous perabrodil M for the average case. The pressure of injection is necessarily higher than with the usual media. A large-gauge needle is used, preferably 1.5 mm. The authors inject percutaneously, cutting down on the artery only if percutaneous injection is not successful. They make films at four, eight, and twelve seconds. If a second injection is required, another 10 c.c. of the medium is used.

The patient may experience a slight feeling of warmth, but pain is unusual. While the authors do not consider the new medium entirely harmless, they have never encountered a serious reaction. The most severe reaction noted so far consisted of minor convulsions, restlessness, and vomiting, coming on at a later period than with the usual water-soluble media. The increased viscosity of the preparation results in sharp clear definition of the vessels.

[The authors do not give the composition of this new medium.]

Five roentgenograms; 1 photomicrograph.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Diagnosis of Traumatic Intracranial Hemorrhage by Angiography. J. E. Webster, R. Dawson, and E. S. Gurdjian. J. Neurosurg. **8:** 368–376, July 1951.

The diagnosis of massive intracranial bleeding in the seriously injured patient is sometimes difficult. Cerebral angiography may be of value in locating a massive lesion and also in differentiating between subdural, epidural, and intracerebral hematomas.

The authors have performed 30 cerebral angiographic studies on a group of seriously ill patients with head injuries, suspected of having massive intracranial hemorrhage. There were 9 subdural hematomas, 2 epidural hematomas, 4 temporal lobe intracerebral collections and 1 "extravasation" lesion, 2 aneurysms, and 10 cases in which there was no evidence of a complicating surgical lesion. There was one false negative and one false positive angiogram.

In cases with a typical subdural hematoma, there is a marked shift of the anterior cerebral artery to the opposite side. The middle cerebral artery may be depressed. If the finer branches of the middle cerebral artery are also visualized, the space occupied by the hematoma may be evaluated by the distance between the skull and cerebral surface vessels. An intracerebral hematoma of the temporal lobe will cause the anterior cerebral artery to shift to the opposite side in part of its extent, but will also displace the sylvian vessels upward and forward. The pattern for epidural hemorrhages in the temporal region is similar to that of the temporal lobe hematoma, but with the former the trunk of the middle cerebral artery is more likely to be dislocated upward. However, with a temporal hematoma, a dislocation of the middle cerebral branches upward and forward is usually the case. The presence of a fracture in the temporal region also may be evidence in favor of an epidural collection.

Unfortunately, there is a disadvantage in moving the patient for the roentgen studies. There is a further risk when pentothal anesthesia is necessary for the unco-operative patient. The time consumed in doing

the arteriogram is a consideration. The question must be raised whether these risks are warranted in the interest of prompt and accurate diagnosis.

Fifteen roentgenograms; 1 table.

HOWARD L. STEINBACH, M.D.
University of California

Diodrast Studies of the Vertebral and Cranial Venous Systems, to Show Their Probable Role in Cerebral Metastases. Robert Anderson. J. Neurosurg. **8**: 411–422, July 1951.

Cerebral metastases are blood-borne, since no lymphatics are present in the brain. Frequently, the cerebral involvement is the only point of implantation secondary to a distant primary lesion. The commonly accepted route of a vascular spread of tumor cells to the brain is along the arterial tree. The manner in which the pulmonary filter is bridged in cases of blood-borne material from the portal system, caval system, and general circulation has not been easily explained. Batson demonstrated, by injecting radiopaque material into the venous system of human cadavers, that media could pass along the vertebral venous system and that this vertebral venous system was in close association with the veins of the body wall, pelvic and shoulder girdles, and venous sinuses within the cranium (Batson: Ann. Surg. **112**: 138, 1940).

The authors injected the deep dorsal penile vein in 10 cadavers and the cephalic vein of the upper arm in 2 cadavers with 52.5 per cent diodrast solution. After 60 c.c. of diodrast had been injected, roentgenograms were obtained. These revealed the presence of the opaque medium in the dorsal vein of the penis and its connections with pudendal, prostatic, and vesical plexuses. The pudendal veins, hypogastric veins, obturator veins, and iliac veins were well outlined, and numerous anastomoses were evident. The ascending lumbar veins and segmental connections with the intervertebral veins and the inferior vena cava were shown. The external vertebral veins and, to a lesser extent, the internal vertebral veins were also demonstrated. In the upper lumbar region there was extensive filling of the renal venous plexuses.

After another injection of 60 c.c. of diodrast into the deep dorsal vein of the penis, a film of the thoracic region demonstrated the opaque substance in the vertebral venous system, with some filling of the inferior vena cava, the hepatic veins, the pulmonary veins, and the right auricle and ventricle. In the upper portion of the thorax on the right side, the superior portion of the azygos vein was seen. There was some filling of the intercostal veins, the deep cervical veins, and the vertebral veins in the lower portion of the neck.

After a total of 200 c.c. had been injected, there was an accumulation of the opaque medium in the superior sagittal sinus and many of the superior cerebral veins. The inferior sagittal sinus, straight sinus, great cerebral vein, petrosal sinuses, and a portion of the basilar plexus of veins were also outlined.

Twenty c.c. of 52.5 per cent diodrast solution was injected into the femoral vein of living human subjects. This demonstrated the filling of the femoral vein and inferior vena cava. However, if a moderate amount of pressure was applied to the abdomen with a compression band, the return flow in the inferior vena cava was impeded and a different venous pattern was obtained. This demonstrated a shunting into the ascending lumbar veins and vertebral veins on the side of injection. The segmental connections between the lumbar vein and vertebral veins could be seen.

Upon four occasions the cephalic vein was injected in the anterolateral aspect of the upper arm. Normally the cephalic vein is shown arching downward into and filling the axillary vein and the subclavian vein. When a similar injection was done, however, while the intrathoracic pressure was elevated by the Valsalva maneuver, very little diodrast passed beyond the subclavian vein; it had "backed up" into all of the transverse cervical, scapular, and deep cervical veins. Also portions of the left internal and external jugular veins and the vertebral venous system were shown.

The vertebral venous system may be looked upon as a continuous chain of vessels extending from the pelvis to the cranial venous sinuses. The venous pressure is relatively low in this system, and the circulation is slow and subject to reversals in the direction of flow. Hence, emboli which have gained access to this venous complex can easily ascend or descend along the vertebral veins. Their direction and ultimate destination depend on such factors as posture and gravity, coughing or straining, and the character of the circulation of allied systemic, portal, and pulmonary systems.

Twelve roentgenograms; 1 drawing.

HOWARD L. STEINBACH, M.D.
University of California

Changes in the Cerebrospinal Fluid After Pneumoencephalography. Edwin R. Bickerstaff. Lancet **1**: 1209–1210, June 2, 1951.

The investigation recorded here, which is a continuation of an earlier study (Lancet **2**: 683, 1950), showed that two distinct types of pleocytosis arise in the cerebrospinal fluid in relation to pneumoencephalography. The first is seen during the actual procedure, starting within the first few minutes and sometimes reaching 252 cells per cubic millimeter within twenty minutes. It is almost entirely mononuclear, the magnitude of the rise being influenced by the height of the initial cell count. The second pleocytosis begins two and a half to three hours after the introduction of air, is more dramatic, and is almost exclusively polymorphonuclear; the greatest reaction is at eight to fourteen hours. Mononuclears then reappear, but the cerebrospinal fluid is neither cytologically nor biochemically normal for at least five days. The cellular reaction is said to be proportional to the quantity of air introduced.

The cerebrospinal fluid protein level rose steadily, reaching 100 mg. per 100 ml. after three hours and remaining at this level until twenty-two to twenty-four hours after the examination.

The pleocytosis after pneumoencephalography is not so difficult to explain as the pleocytosis during the procedure. The later reaction is typical of an acute irritation of the meninges. The author is of the opinion that no diagnostic significance can be attached to these findings, as the same type of reaction, with the same variations, occurs in neurologically normal persons and in patients with gross organic disease.

Pituitary Tumours: Observations on Large Tumours Which Have Spread Widely Beyond the Confines of the Sella Turcica. Hugh C. Trumble. Brit. J. Surg. **39**: 7–24, July 1951.

The author's study of the spread of pituitary tumors and their effects on surrounding tumors or tissues is

based chiefly upon observations of 13 postmortem specimens.

A pituitary adenoma at first expands uniformly in all directions. As resistance is met within the sella turcica, the growth bulges asymmetrically in the line of least resistance. Large pituitary tumors spread in three main directions: downward and forward, laterally, and upward.

The floor of the sella turcica offers little resistance to *downward* growth. The sphenoid sinus and the nasopharynx are invaded, and eventually the growth can push into the anterior cranial fossa through the roof of the sinus.

Laterally, little resistance is offered by the medial wall of the cavernous sinus. The interclinoid ligament and the attachment of the tentorium cerebelli stand firm, but beneath these the tumor can proceed either over or under the carotid artery, bending and surrounding it. Beyond the cavernous sinus, extension is hindered by the attachments of the dura to the foramina at the floor of the middle cranial fossa.

Upward growth occurs through the opening in the diaphragm which roofs in the pituitary fossa to allow the passage of the pituitary stalk. Dilatation of this opening is limited by the interclinoid ligaments. The tumor may continue in front of or behind the optic chiasm. Anteriorly the enlarging adenoma pushes up into the medial surfaces of the frontal lobes, stretching the lamina rostralis and bulging into the frontal horns of the lateral ventricles. Further back, the tumor indents the floor of the third ventricle, spreads the peduncles, and pushes the mid-brain posteriorly, where it becomes compressed against the free edge of the tentorium cerebelli.

Although the optic nerves, chiasm, and tracts are grossly distorted and flattened by the expanding tumor, function may be unimpaired. The lack of correlation between function and anatomical distortion is true of other cranial nerves and should be remembered in the clinical investigation of a case.

Plain roentgenograms of the skull seldom show opacities in the pituitary adenoma. Pressure effects on the cranial bones and displacement of the pineal gland, if this is calcified, will give some information. Within the sella turcica, if the floor is intact, the size of the subdiaphragmatic portion of the growth can be estimated. After the tumor has invaded the sphenoid sinus, its outline can sometimes be seen because of the air in the sinus. Lateral invasion into the cavernous sinuses can seldom be detected on the plain film. Pneumography gives important information concerning supradiaphragmatic extension. Pressure effects on the frontal horns, temporal horns, and third ventricle are some of the abnormalities to be looked for. Sometimes the pattern of air in the basal cisterns indicates the extent of the lesion.

Angiography was not employed in these cases, but is regarded as a most valuable method of gaining information as to the location of the tumor and the disposition of important vessels in relation to it.

The author shows how an accurate knowledge of the anatomical extent of the tumor aids in planning and executing operation. The article is particularly notable for its many excellent diagrams illustrating the pathological anatomy discussed in the text.

Twenty-seven diagrams and photographs.

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Air Cells in the Great Wing of the Sphenoid Bone. Russell Wigh. Am. J. Roentgenol. **65:** 916–923, June 1951.

A variation in the pneumatization of the sphenoid bone, consisting of an accessory nasal sinus compartment in the vertical plane of its great wing, is described. It can be identified on the frontal sinus projection by a central radiolucency in the greater wing of the sphenoid, surrounded by a well defined sclerotic margin which is smooth or occasionally undulatory. The inferior portion is usually concealed by the projection of the petrous pyramid. Even in a Waters' projection the low boundary of these air cells may be obscured because they continue posteriorly into the floor of the middle fossa. The aerated portion may be multilocular, and it may be bilateral.

This accessory sinus should not be confused with a well defined transverse venous sinus which is occasionally seen as a radiotranslucent area in the same projection. A very thin sphenoid wing may appear translucent and closely resemble an air cell. Also, a radiolucent area representing a portion of the inferior orbital fissure may cause confusion.

On a frontal roentgenogram of good detail one can identify the mucous membrane of the cell. In the basilar view of the sinuses or skull the sphenoid sinus will be seen to be very large, and to have recesses which extend lateralward beyond the foramen ovale and anticipated position of the foramen spinosum. The foramen ovale may be deformed by the encroachment of the air cell.

On the lateral roentgenograms the body of the sphenoid is almost always well aerated. Specific inspection of the anterior boundary of the middle fossa will reveal that this is actually a double wall on the homolateral side, enclosing the air cell.

In 2,190 consecutive skull studies, pneumatization of one or both vertical plates of the great wings of the sphenoid was found 16 times. The author believes that this variant occurs in about 1 per cent of adult skulls. It should not be misinterpreted as a pathological change.

Fourteen roentgenograms; 4 photographs.

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Rhinological Aspects of Chronic Dacryocystitis Francis Henry McGovern. Virginia M. Monthly **78:** 74–76, February 1951.

The author reports a small series of cases of chronic dacryocystitis, pointing out that allied diseases in the paranasal sinuses, mucous membranes, and bony structures of the nose are important factors in producing this clinical entity. In a series of 110 cases reported by another observer, the causes were as follows:

Chronic rhinitis	21
Atrophic rhinitis	3
Trauma	5
Deviation of septum	4
Chronic sinusitis, usually ethmoid, occasionally associated with maxillary sinusitis	57
Vasomotor rhinitis	2
Polyposis nasi	3
Syphilis of sac	2
Tuberculosis of sac	1
Osteoma	1
No nasal disease	9

The literature is further reviewed and it is stated that between 75 and 80 per cent of the cases occur in women, usually at the time of the menopause. It is felt that endocrine, developmental, hereditary, and anatomical considerations are significant.

The importance of visualization of the lacrimal ducts is emphasized, and it is pointed out that there are certain contraindications to operation which can be discovered by this method. Diverticulum of the sac alone reduced the possibility of surgical cure by 30 per cent. Polyps within the sac are also considered contraindications.

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THE CHEST

Roentgen Anatomy of the Lungs. G. Herrnheiser. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 623–648, June 1951. (In German)

The author attempts to clarify the rather confused ideas regarding anatomy and nomenclature of the bronchi and pulmonary vessels. The accepted normal pattern has many variations. These are generally classified in four groups:

(1) Variations in point of origin: (*a*) separation; (*b*) fusion; (*c*) displacement; (*d*) transposition.
(2) Variations in number: (*a*) aplasia; (*b*) duplications; (*c*) accessory branches.
(3) Variations in caliber.
(4) Variations in direction.

Generally speaking, these variations seldom influence the anatomy of the main divisions to any practical extent.

The lung lobe is divided into (1) an inner or root zone, (2) a nuclear or mid zone, and (3) a mantle or outer zone. Each zone differs somewhat anatomically and functionally. The outer or mantle zone dips inward between the nuclear zones and extends centrally to the hilar region. This is best observed roentgenographically in the lateral projection. Within the root zones are bronchi of the first and second, and a few of the third order. Within the nuclear zone are bronchial divisions of the second, third, and fourth orders, while the mantle zone contains the finer divisions of the third, fourth, and fifth orders.

Pathological changes occurring either totally or chiefly within the mantle zone are lung abscess (especially in an early stage), the primary tuberculosis complex, early tuberculous infiltrates, early stages of pneumonic processes, and small infarcts. In the nuclear zone, apart from hilus carcinomas, are to be found the early stages of pulmonary edema and interstitial processes (silicosis, etc.). Atelectasis often involves both mantle and nuclear zones.

All the bronchi and their vessels in the mantle zone are of small caliber—1 mm. or less. Thus, roentgenologically only fine linear structures are demonstrable under normal conditions. Shadows in this zone measuring more than 2 mm. are to be considered abnormal. The boundary between the mantle and the nucleus may be fairly well recognized on many plain chest films, approximately 4 cm. from the thoracic wall. The root zone contains vessel nerves, lymph nodes, and supporting connective tissues.

At the International Congress for Oto-Rhino-Laryngology, held in London in 1949, a committee was formed to designate the number and names of the bronchial divisions and the corresponding segments of the lung.

The nomenclature adopted by the Congress is as follows:

	Right Lung	Left Lung
Upper Lobe	1. Apical 2. Posterior 3. Anterior	Upper Division 1 and 2. Apical posterior 3. Anterior Lower Division
Middle Lobe	4. Lateral 5. Medial	4. Superior lingular 5. Inferior lingular
Lower Lobe	6. Apical 7. Medial-basal 8. Antero-basal 9. Latero-basal 10. Postero-basal	6. Apical 7. Absent (supplied by branch of 8) 8. Antero-basal 9. Latero-basal 10. Postero-basal

In a study by selective injection and dissection the veins showed, in general, a pattern corresponding to the bronchi, though some measure of variation was observed. An occasional subpleural vein, somewhat inconstant on the left side but fairly constant on the right, was named separately. The distribution of the main arterial divisions was identical with the bronchi and they were similarly designated.

Acceptance of the terminology of the International Congress is recommended for general use, as a means of clarification and avoidance of the complications in the older systems.

Twenty-nine figures, including 5 roentgenograms.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Bronchography in Tuberculosis. G. Ibers, H. Vieten, and K. H. Willmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 667–676, June 1951. (In German)

Bronchography has been avoided in tuberculosis because the iodized oil sometimes leads to dangerous results and even death. It may cause the spreading of an active process and, when done for other reasons, has apparently led to reactivation of an old quiescent process. With the newer water-soluble solutions, especially when the study is limited to a single lobe or segment, the question again arises as to whether tuberculosis should be considered an absolute contraindication to bronchography.

The authors' report is based on 43 bronchographic studies in tuberculous patients with viscous perabrodil M (60 per cent). They claim that resulting complications are minimal. There is frequently a slight rise of temperature for twenty-four to forty-eight hours, not always definitely traceable to the injection. Slight increase in expectoration was noted for a few days but is not considered of significance. There has been no

proof of actual spread of any lesion even in definitely active areas. One patient in the series showed a mottled density on the opposite side after the study, but as this cleared up very shortly it was considered to be on the basis of a non-specific bronchopneumonia and unrelated to the study.

The ability to perform bronchography in patients with tuberculosis is of special importance in relation to surgery as it often furnishes a basis for judgment as to removal of a segment or lobe of the lung for chronic irreversible changes, atelectasis with involvement of a large bronchus, bronchiectasis, residual cavities following thoracoplasty, etc. Bronchographic examination is, of course, of value only when definite involvement of the bronchi is present; processes limited to the alveoli are not amenable to investigation.

The chief findings comprise the so-called "pearl string" appearance identified by irregularity of outline, absence of alveolar filling in the area of distribution, and irregular broadening and narrowing of the lumen (early involvement) in tuberculosis; bronchiectasis, often in the upper lobes; bronchial stenosis and the condition of the lung segment distal to this region; recognition of bronchogenic carcinoma (when possible); localization of cavities and condition of the draining bronchus, and demonstration of residual cavitations, fistula, etc., after thoracoplasty.

Nine roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Bronchographic Study of Dyspnea. P. L. Martin. J. de radiol. et d'électrol. **32**: 577–583, 1951. (In French)

This study excludes dyspnea secondary to such lesions as bronchogenic carcinoma, being limited essentially to asthma. The patients were submitted to bronchographic examination between crises.

Stagnation in the larger bronchi was often noted. The lipiodol penetrated to bronchi of the fourth order and might progress no farther for ten or fifteen minutes. A second interesting observation was a variable diminution of bronchial caliber. The bronchial impression might be abruptly terminated and there was absence of alveolar filling.

These bronchographic signs of stasis, reduction of bronchial caliber, amputation of bronchial shadows, and lack of alveolar filling, are not all seen in all patients. It is also noted that patients with emphysema and without asthma may present similar findings.

There is considerable speculation as to the cause of the signs. Mucus in the bronchial tree is often suggested as a basic factor. Métras (Presse méd. **53**: 579, 1945) infiltrated the cervico-thoracic sympathetic nerves with novocain, and carried out a second bronchographic study a month later. He then noted alveolar filling. This would suggest that bronchiolar spasm plays a prominent part in the production of the signs described.

A case is cited in which bronchogenic spasm was not noted but in which expiratory bronchial collapse was present. At bronchoscopy edematous mucosa was seen. After therapeutic infiltration of the cervico-thoracic sympathetic nerves, dyspnea was relieved and expectoration increased. This reversible condition suggests that the neurovegetative system plays an important role in these cases.

Ten bronchograms. CHARLES M. NICE, M.D.
University of Minnesota

Does Joduron Bronchography Damage the Lung Parenchyma? A Contribution to the Pathogenesis of Granulomatous Changes and Xanthomatous and Interstitial Pneumonia in Primary Lung Processes. Hans U. Zollinger. With remarks by W. Vischer. Schweiz. med. Wchnschr. **81**: 210–216, March 3, 1951. (In German)

According to the author's experience, lipiodol has occasionally caused severe granulomatous changes in the lungs. He therefore employs Joduron B, a water-soluble iodine compound, for bronchography. Experiments on 12 guinea-pigs and studies of 25 surgical specimens and of one case coming to autopsy led to the conclusion that Joduron B can be tolerated by healthy and even severely diseased lungs without any permanent morphological changes. In other words, Joduron B does not damage the lung parenchyma.

Interstitial granulomas have been observed following bronchography, but these were due to bronchial obstruction, the result of mucous plugs. A special staining method described by the author makes it possible to distinguish between mucus and the cellulose compound contained in Joduron B. Numerically, no increase was observed in the number of granulomas in cases in which bronchography was done as compared with others.

The stasis of mucus in the bronchi is responsible for the different types of pneumonia observed. The first phase is a granular mucus accumulation and pneumonia with desquamation of epithelium. The following stage is a xanthomatous pneumonia, and the third stage the chronic interstitial type.

In a postscript to the article the author recognizes the fact that his results are contrary to those of W. Vischer, who considered Joduron B responsible for granulomas in the lung parenchyma (Schweiz. med. Wchnschr. **81**: 54, 1951. Abst. in Radiology **57**: 900, 1951). Vischer's results are said by Zollinger to be misleading, because his staining methods did not distinguish between mucus and other deposits in the tissues. Zollinger regards the changes reported by Vischer as typical mucous reactions.

In a note following the paper, Vischer replies that he has never observed granulomas in cases in which bronchography was not done and that following the procedure he has encountered changes in areas which were not affected by any disease.

Four photographs; 7 photomicrographs.
EUGENE F. LUTTERBECK, M.D.
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Radiological Diagnosis of Emphysema. J. M. S. Knott and Ronald V. Christie. Lancet **1**: 881–883, April 21, 1951.

It has been claimed that emphysema presents characteristic radiologic appearances, and it was the purpose of the investigation described here to test the validity of this claim.

Twenty patients, aged forty-five to sixty, with a clinical diagnosis of moderate or severe emphysema, were selected from an outpatient clinic. Each of these patients had the physical signs of emphysema and a history of chronic bronchitis for many years and, more recently, of increasing breathlessness on exertion which could not be explained on any basis other than emphysema. As a control, 20 patients were selected with no abnormalities of the cardiovascular or respiratory systems. In each group, four roentgenograms of

the chest were obtained for each patient, postero-anterior and lateral views on full inspiration and full expiration. These were numbered at random and submitted to a physician and three radiologists, all of whom had special experience in this field. The x-ray findings were assessed on the following criteria:

Postero-Anterior Roentgenogram: In emphysema the thoracic cage is usually large and the diaphragm may be low, flat, and irregular. Hypertrophy of the pectoralis muscles may be seen. The ribs may tend to lie horizontally, and the intercostal spaces and subcostal angle may be wide. The heart may appear to lie vertically, with a prominent pulmonary conus and exaggerated pulmonary arterial shadows at the lung hili. The medium-sized vessels tend to stand out more clearly but are smaller in caliber than normal. The smaller peripheral vessels may also be more clearly visible than normal. The lung fields may show increased translucency, particularly at the bases. Individual bullae may be seen, usually at the apices of the lungs.

Lateral Roentgenogram: The thoracic cage is large and there is often kyphosis affecting all the dorsal vertebrae. The diaphragm is usually low, and its movements on inspiration and expiration, as well as those of the sternum, may be diminished. The space between the sternum and the heart is almost invariably increased. In other respects the lateral film confirms the findings in the postero-anterior film.

All 4 observers made a correct diagnosis in 14 of the 20 patients with emphysema; 3 observers were in agreement on another 4. In 2 cases 3 observers were of the opinion that emphysema was not present. In the control group, emphysema was diagnosed in 4 persons, in each instance by only a single observer. On the basis of the postero-anterior film in full inspiration, 4 observers agreed on a diagnosis of emphysema in 15 cases, 3 agreed on another case, and 1 diagnosed emphysema in another 3. There was, however, considerable disagreement in the reports on the normal group, emphysema being diagnosed in no less than 12 of the controls.

After a brief discussion of the radiologic features of emphysema, the authors conclude that a diagnosis based on a single postero-anterior film is of doubtful significance. Even with films taken in the postero-anterior and lateral positions, in both inspiration and expiration, about 10 per cent of the cases will be missed, and in a few instances emphysema will be reported when the lungs are actually normal.

Three tables.

Artificial Pneumothorax: A Statistical Analysis of 557 Cases Initiated in 1930–1939 and Followed in 1949. I. Influence of Clinical Findings Before Induction on Early and Late Results. II. The Fate of the Contralateral Lung. III. Influence of Features of Management After Induction on Early and Late Results. Roger S. Mitchell. Am. Rev. Tuberc. **64**: 1–20; 21–26; 27–40, July 1951.

The author has made an extensive statistical study of a large group of patients seen at the Trudeau Sanatorium (Trudeau, N. Y.) in whom pneumothorax was induced as a therapeutic measure. In the first three of a series of papers he considers the influence of pre-induction clinical factors on the outcome, the fate of the contralateral lung, and the relationship of features of management to the late results.

The sex of the patient, the side of pneumothorax, location of the cavity, thickness of the cavity wall, and the presence of fluid level within the cavity were found to bear no relation to the results of the procedure. On the other hand, the age of the patient and of the disease were important. Patients over the age of thirty-four responded less well than younger ones. "Old" disease, as evidenced by signs of pulmonary contraction, string-like densities, and calcification, was not controlled as readily as more recent disease. The late (three years after abandonment of pneumothorax) results in endobronchial disease as evidenced by the presence of tubercle bacilli in the sputum without cavitary disease, as well as in endobronchial disease manifested by roentgen signs of bronchiectasis, contracted lobe or lung, a lobar distribution, and negative findings in the presence of positive sputum, were considerably less favorable than in cavitary disease. As would be expected, moderately advanced disease responded better than far advanced lesions. The character of the disease as reflected by the density of the roentgenographic shadows proved to be an important factor in the results. The lighter the shadows the more likely a good result. Another important factor was the activity of disease, if present, in the opposite lung; the results were proportional to the extent and activity of the disease, with a poor response in those with advanced active contralateral lesions.

Re-activation of disease in the contralateral lung was found to be directly related to the presence and activity (but not extent) of disease in that lung, with little activation in cases in which no disease was seen and in cases in which it was originally adjudged "inactive." A relationship was also demonstrated to the density of the roentgen shadows in the collapsed lung, the less dense lesions being accompanied by less contralateral reactivation. Poor anatomic collapse resulted in a significant increase in contralateral reactivation as compared to that in cases with satisfactory anatomic collapse.

In the management of pneumothorax, the degree of freedom from adhesions was found to be the most important single factor, with the results good in a large proportion of those patients in whom satisfactory anatomic collapse could be obtained. Only 11 per cent of the present series had an anatomically satisfactory collapse without pneumonolysis. The speed of cavity closure and sputum "conversion" were also of importance, with the results better in those patients whose cavities closed and sputum became negative in a relatively short time (one to four months). Lower lobe disease was found to be associated with significant pleural adhesions to a lesser extent than upper lobe disease. No close relationship between duration of pneumothorax and results was observed, and studies in regard to the effect of rest were inconclusive.

There are a total of 36 tables in these three articles, all giving percentages of difference in results when the factors given above are considered. Because of their large number, these percentages have not been presented in this abstract. The criteria for evaluating "good" results, etc., were also considered too lengthy to be included.

Six roentgenograms (in Part I).

JOHN H. JUHL, M.D.
University of Wisconsin

Roentgen Characteristics of the Silicoses in Relation to Occupation. R. Haubrich. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 385–408, April 1951. (In German)

In this lengthy paper the author gives a differential diagnosis of various forms of silicosis in workers exposed to dust inhalation and classifies the changes according to the type of industry.

The only difficulty, according to the author, in differential diagnosis of silicosis in general may be encountered in cases of chronic edema of the lung with hemosiderosis or miliary tuberculosis. The pattern and distribution of the silicotic lesions, however, are different, as they are more commonly seen in the subpleural lateral aspects of the middle and upper lung fields.

(1) *Stone Masons and Quarry Men:* Sandstone contains about 80 to 90 per cent of pure silica, and workers employed in this industry show very dense, homogeneous nodules, sharp in outline, with some variations depending upon the silica content of the dust and type of employment. Egg-shell calcifications of the hilar nodes are noted, being present, according to some authors, in about half the cases. They are typical for silicosis and therefore valuable in the differential diagnosis when tuberculosis is suspected.

(2) *Grinders:* The lung changes in grinders are similar to those in stone masons, but in this occupation the dust is more dangerous when used wet. The so-called "snow-storm" pattern is seen, and at a relatively early stage one can discern the presence of large dense nodules. A severe progressive tuberculosis often complicates the picture. In these cases, there is occasionally a discrepancy between the roentgen findings and the clinical picture. *Sand blasters* also inhale fairly pure silica, and the changes manifest themselves in the form of massive fibrosis, but spotty densities are occasionally noted after a very short exposure.

(3) *Soap and Scouring Powder Industry:* Scouring powder contains up to 100 per cent silica, and the silicoses seen in this form of work develop after a short exposure, sometimes less than two years. They are quite severe and are accompanied by tuberculosis. The roentgen pattern discloses small, hard, granular densities with an accompanying emphysema.

(4) *Ruhr Miners:* Miners in the Ruhr district are subject to mixed dust inhalation, and the roentgen picture depends upon the type of work performed.

(5) *Siegerland Ore Miners:* The Siegerland miners present a different roentgen pattern from the Ruhr miners. In the latter, one sees larger nodules, whereas the former show finely granular and stippled areas, as seen in ochre-dust lungs.

(6) *Pottery Industry:* According to Nicol, the materials used in potteries contain about 15 to 30 per cent of silica. The clinical picture develops after long exposure, sometimes several years after the work has been discontinued. The densities are soft and rather ill defined. The size is variable, and a peculiar bronchiectasic component is noticeable. In the third stage, a spontaneous pneumothorax occurs quite often.

(7) *Clay Industry:* Depending upon the constituents of the material used and the type of work performed, one sees different roentgen pictures in clay workers. There may be a finely reticulated pattern with dense fibrotic strands; sometimes large opacities are seen, with poorly circumscribed borders.

(8) *Other Forms of Silicoses:* To this group belongs the ochre type of lung, with a finely granular pattern.

(9) *Acute Silicoses:* The term "acute silicosis" has been used when, after a relatively short exposure—two to four years—a typical roentgen and clinical picture of silicosis is noted, as for example in the scouring powder industry. The designation could be better applied to cases in which, after a short exposure, a roentgen pattern is seen which differs from that in other silicotic lungs. This occurred during the war in miners and sappers working in mines and tunnels without protection and inhaling dust containing about 50 to 70 per cent of pure silicic acid. Out of 22 persons exposed to dust between six and one-half to thirty-six months, 12 died within six years. The roentgen picture was very characteristic, with predominant involvement of the lower lobes. Chronic silicotic changes are usually localized in the middle and upper lobes.

(10) *Combined Forms:* Sometimes a worker changes his place of employment and is thus exposed to different types of dust. This produces a mixed pattern in the lung.

Finally the author describes the use of tomograms in the differential diagnosis of silicosis and points out that in this way the hilar calcification, type of radiopacity, and location and size of cavities can be easily detected. He states that there is no cut and dried differential diagnosis possible between silicotic and tuberculous cavities or a combination of both.

Thirty-eight roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Case Record Contribution to Acute Silicosis. R. Grohmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 676–680, June 1951. (In German)

Acute silicosis is seldom observed in Germany. It usually follows relatively short occupational exposure (three years or less) and runs a rapidly fatal course. A case is reported in a 19-year-old soldier working as a miner in a French prison camp for approximately eighteen months, from 1945 to the beginning of 1947. No complaints were present until the latter part of 1946, at which time moderate cough and shortness of breath developed. These symptoms were somewhat exaggerated in the early part of 1947. Roentgenograms showed small flocculent shadows within the mottled and striped areas and exaggeration of the hilar and linear markings, particularly in the lower portions of the lung fields. Tuberculosis and Boeck's sarcoid were considered in the differential diagnosis. The symptoms increased rapidly, and the x-ray studies showed continued extension of the mottling, with larger confluent areas of infiltration, emphysema, and an apical pneumothorax on the left side. The heart was slightly enlarged. Death occurred from pulmonary edema eighteen months after the initial symptoms.

Similar cases are said to have been reported in the American literature, from Virginia, as occurring during the process of tunnel digging.

Four roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Multiple Ossifications in the Lungs of a Stone-cutter. J. R. Rüttner and H. Eggenschwyler. Schweiz. med. Wchnschr. **81**: 442–445, May 12, 1951. (In German)

A 70-year-old quarry worker had a cough for years, productive of white, glairy sputum. He suffered

from fatigue and breathlessness. Examination disclosed anoxia, an increased amount of CO_2 in the arterial blood, increased CO_2 tension, hyperventilation, and diminished vital capacity. The radiologic findings were consistent with silicosis, grade II–III, and questionable tuberculosis, and the patient was hospitalized. One and one-half years later acid-fast bacilli were found in the sputum and a tomogram showed a cavity in the right upper lobe. After four years of hospitalization, death occurred from circulatory failure.

Radiologic findings were a symmetrical emphysematous thorax with numerous calcareous patches in the upper and lateral parts, varying in diameter from 2 to 5 mm. Bilaterally, there were chalky plaques beneath the apical pleura; the hili were enlarged, with calcified lymph nodes. Autopsy revealed silicotic foci measuring 10 to 15 mm. In the upper lobes these foci were ossified in the form of a cup. In both lung fields, but chiefly in the middle segment, were partially ossified nodules. Silicosis was found in the tracheobronchial, iliac, and axillary lymph nodes. There was advanced bullous emphysema of both apices and chronic emphysema of both lung fields.

This case is of interest because of the unusual pulmonary ossification. In other cases isolated solitary ossified nodules have been found, but in this case nearly all the silicotic nodules had a tendency to ossify and in places to form cellular bone marrow. The silica crystals were converted into silicotic nodules, which in time underwent calcification and later ossification. This process could be viewed as an aging of the silicotic lesion. A long life span is necessary for the assumption that silicotic tissue may ossify.

On a single film it cannot be determined whether or not the shadows represent calcification or ossification. The absorption of x-rays in both instances is the same. A decrease in size of the shadows which may be observed throughout a period of years is partially explained by the ossification. The ossification could be seen on a tomogram, where it was apparent as cup-like shadows. On the regular films the ossified lesions could not be detected.

Tuberculosis in this case was coincidental and did not play any part in the ossification.

Seven illustrations, including 4 roentgenograms.

ILONA D. SCOTT, M.D.
VA Hospital, Chamblee, Ga.

The Aluminum Lung. Karl-Heinz Ehrecke. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 408–411, April 1951. (In German)

The author reports the case of a 40-year-old patient who ten years earlier was employed for two years (1937–39) in a factory where he inhaled aluminum-bronze dust. At that time, several employees had gastro-intestinal complaints. In 1941 changes in the patient's lungs were discovered on fluoroscopy, and these had remained stationary over the years. For the past year the patient had experienced dyspnea on slight exertion and some expectoration. The roentgen findings disclosed dense, streaky and patchy opacities, especially in the upper lobes, with interspaced emphysema, particularly at both bases. The trachea was displaced to the right, and tomographic studies disclosed a noticeably large and dense collection of hilar lymph nodes, a widening of the bronchial tree, and bronchiectatic cavities.

The author discusses the pathogenesis and underlying pathological anatomy of the aluminum lung.

Three roentgenograms. JULIAN O. SALIK, M.D.
Baltimore, Md.

The Roentgen Picture in Cases of Lung Mycosis. Nils F. Bothén. Acta radiol. **36:** 35–46, July 1951.

Three cases of pulmonary mycosis are presented. Two of these were defined as primary pulmonary moniliasis. In the third case lung changes simulating pneumonia were treated by antibiotics, which arrested this process but apparently created conditions favorable for the growth of a fungus in the lungs. *Monilia* was isolated from the sputum and the pathological diagnosis was moniliasis.

While the most important findings in lung mycoses are made by roentgen examination, the roentgen diagnosis can be only tentative. The findings are far from typical and may simulate those in other pulmonary diseases. Of great importance, apart from the roentgen findings, are a history of exposure to dust, the discovery of fungi by sputum culture, study of specimens obtained by bronchoscopy, type examination of the fungus, investigation of its pathogeny and virulence, and the effect of the specific treatment.

Generally speaking, in the acute stages of lung mycoses, the roentgen changes resemble those in acute non-specific infections such as bronchial pneumonia. In chronic cases the changes simulate those in tuberculosis. In early pulmonary moniliasis only the bronchi are affected and roentgenologic changes may be slight. These consist of peribronchial densities with occasional linear fibrosis. When the process is more advanced, it is frequently seen to begin in the hilar regions, fanning outward in the lung parenchyma. The hilar shadows are often diffusely enlarged. In the parenchyma the acute changes consist of small, smudged, patch-like densities. Usually both lungs are involved. The changes are chiefly localized in the middle and lower lung fields, being less marked at the apices. The same is true of other pulmonary mycoses. The lesions may become confluent. The pleura may be involved, with resultant effusion. Cavities have been reported but are unusual. The disease may go on to generalized fibrosis, it may heal altogether with disseminated calcifications, or there may be occasional regressions without treatment, with the roentgen picture gradually becoming normal.

The pulmonary mycoses resemble not only each other but virus pneumonia, carcinomatosis, pneumoconiosis, sarcoidosis, and tuberculosis. The latter can sometimes be ruled out with a fair degree of certainty when one notes that the apices may be spared in the pulmonary mycoses.

In an attempt to differentiate the pulmonary mycoses on the basis of the roentgen pictures, the author notes that miliary patches are unusual in actinomycosis and aspergillosis; cavities are unusual in moniliasis; and abscesses, fistulae, and pleural exudation are very common in actinomycosis but less so in the other mycoses. Mixed infections by different fungi increase the difficulty in diagnosis.

Treatment with antibiotics, particularly aureomycin, may produce favorable conditions for the growth of a fungus in the lungs and elsewhere. This may lead to an increase in the number of cases of lung mycosis.

The author's cases accent the non-specificity of the roentgen findings. One patient showed enlarged hilar

shadows with widespread patchy opacities in both lung fields; the second showed enlarged hilar shadows with parenchymal changes consisting partly of patchy opacities and partly of fibrotic streaky network; the third showed only linear fibrotic changes. In each case the changes were confined to the lower two-thirds of both lung fields.

Nine roentgenograms. BERTRAM LEVIN, M.D.
Chicago, Ill.

Blastomycosis of the Lung. C. C. Lowry, N. H. Kraeft, and F. A. Hughes, Jr. Am. J. Surg. **81:** 676–679, June 1951.

A case of pulmonary blastomycosis treated by lobectomy is reported. The patient, a 30-year-old colored male, had symptoms suggesting pulmonary inflammatory disease and had experienced one episode of hemoptysis. Roentgenograms showed a well demarcated oval homogeneous density in the right lower lung field posteriorly. The preoperative diagnosis was cyst of the lung. The lesion proved, however, to be an irregular mass of granulomatous tissue, 8 cm. in diameter, containing budding organisms. The diagnosis of blastomycosis was made microscopically. The patient had no other lesions and eight months later there was no evidence of residual disease.

Two roentgenograms; 2 photomicrographs.
ADELE KYNETTE, M.D.
University of Pennsylvania

Pulmonary Shadows in Q-Fever. R. Glauner. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 411–416, April 1951. (In German)

The author describes and discusses the roentgen picture seen in cases of Q-fever on the basis of 12 patients whom he observed. In addition, he surveyed the films of 20 patients from other hospitals. He came to the conclusion that there is no characteristic roentgen pattern which would permit a differential diagnosis between Q-fever and virus pneumonia. In one-third of the cases, there was a fairly homogeneous, ground-glass opacity, and on this basis one could expect that either a grippe or Q-fever was present. In another third of cases, the opacities were similar to those seen in so-called atypical pneumonitis. In the remaining cases the roentgen patterns resembled those seen in tuberculosis, eosinophilic infiltrates, bronchial pneumonias especially of the lower lobes, lobar pneumonias especially when located at the base of the right upper lobe, metastases from neoplasms, syphilis, or actinomycosis. Sometimes, however, the lung changes were seen on the second day, before serologic confirmation was available, and were therefore helpful in about one-third of the cases.

Four roentgenograms. JULIAN O. SALIK, M.D.
Baltimore, Md.

Coin Lesions of the Lung. Daniel L. Fink. Minnesota Med. **34:** 554–555, June 1951.

The term "coin lesion" has been used to denote a solitary lung nodule, measuring 6 cm. or less in diameter, completely surrounded by normal tissue.

In this study of 30 cases, an attempt is made to differentiate malignant from benign nodules. Ten cases showed calcification on the roentgenogram, and not one of these proved to be malignant. Of the remaining 20, 50 per cent were malignant. The author states: "This would therefore indicate that the presence of calcification is diagnostic of the benignancy of the lesion, while in the absence of calcium, there is 50 per cent chance that the lesion is malignant," and again: "It is felt that the coin lesions with calcification need not necessarily be submitted to surgery."

[Such conclusions appear unwarranted on the basis of so small a series.—B.L.]

Six roentgenograms. BERTRAM LEVIN, M.D.
Chicago, Ill.

Surgical Treatment of Circumscribed Intrathoracic Lesions: Lesions Found on Routine Thoracic Roentgenologic Examinations, with Absence of Subjective Symptoms. Stuart W. Harrington. Dis. of Chest **19:** 255–269, March 1951.

This article covers lesions found on routine thoracic roentgenologic examinations in the absence of subjective symptoms. The author begins by stating that his primary purpose is to point out the importance of establishing a definite diagnosis of all abnormal lesions found in the thorax by roentgenologic studies, regardless of whether or not subjective symptoms are present. He reviews the findings in 291 extrapulmonary and intrapulmonary lesions of the thorax. Of 52 symptomless thoracic tumors, 12 (or 23 per cent) proved to be malignant. Dr. Paul Sampson, in his discussion of this paper, pointed out the usefulness of anterior scalene and retroclavicular lymph node biopsy.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Solitary Pulmonary Adenoma (Focal Pulmonary Adenomatosis): A Three-Year Follow-Up After Resection. George P. Rosemond, Katharine R. Boucot, and Ernest Aegerter. J. Thoracic Surg. **22:** 99–103, July 1951.

A photofluorogram of a 16-year-old boy revealed a round mass, several centimeters in diameter, in the left lower lung field, with central rarefaction. The boy was asymptomatic and remained so. Check roentgenograms disclosed no evidence of change in the lesion until thirty-nine months later, when it was found to have increased slightly in size.

Physical examination was negative. Bronchoscopy and needle biopsy were not helpful. Laboratory findings were normal. Exploratory thoracotomy was done, and a subpleural mass in the left lower lobe, located along the fissure, was removed.

The mass, 7 cm. in diameter, was partly cystic and contained clear, sticky fluid, resembling egg white. The cylindrical cells were arranged in pulmonary alveolar pattern. The alveolar lumen contained mucinous material. Malignant characteristics were not found cytologically. The final diagnosis was focal adenomatosis.

Postoperatively the boy did well. No recurrence was demonstrable roentgenologically after forty months.

Five roentgenograms; 3 photomicrographs.
DONALD DEF. BAUER, M.D.
St. Paul, Minn.

Bronchiogenic Cysts. Report of Two Cases. Elmer C. Rigby and Phillip L. Rossman. California Med. **75:** 45–47, July 1951.

The authors report two cases of bronchogenic cyst occurring in patients seventy-five years and twenty

years of age. In each case the cyst occurred in the right hilar region, lying anteriorly in the older patient and posteriorly in the younger.

Differentiation from a malignant neoplasm can seldom be made clinically, and exploration should be done, with complete removal of the cyst. Carcinomatous change has been known to take place in the epithelial lining of bronchogenic cysts, but this is unusual.

Four roentgenograms. FRANK T. MORAN, M.D.
Lancaster, Penna.

Contributions to the Pathological Picture of Bronchial Adenoma. H. Finke. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 659–667, June 1951. (In German)

Bronchial adenoma comprises 6 per cent of all bronchial neoplasms. It is observed to progress through three stages: In the *early stage* cough, slight expectoration, and hemoptysis and dyspnea on exertion may be the only subjective findings. Physical examination is usually entirely negative, and the blood picture and sedimentation time as well as the x-ray and fluoroscopic findings are usually entirely normal. In the *second stage* bronchial obstruction is frequently present, secretion plugging the bronchus and resulting in atelectasis. Pleural complications are usually absent and the lesion may easily be mistaken for a tuberculous process. The atelectasis may be merely temporary but shows a tendency to recur after months or years, often associated with bronchopneumonic areas. A surprising absence of clinical symptoms marks this stage. Tomography and bronchoscopy are valuable in establishing the diagnosis. The *third stage* is one of irreversible complications. The lung tissue loses its normal resistance, and chronic infiltration with abscess, bronchiectasis, pleural complications, empyema, etc., are found. Death is frequently due to the complications rather than the initial condition.

Bronchial adenoma progressing over a period of years show a definite tendency to metastasize, especially to pleura, hilar lymph nodes, other bronchial regions, liver and vertebrae. The condition is usually first recognized between twenty and forty years of age.

The degree of bronchial stenosis is of special importance in estimating the prognosis. Four grades of stenosis are recognized: (1) simple stenosis with slight hindrance of air passage, about equal in inspiration and expiration; (2) valve-like stenosis, with partial delay on inspiration only; (3) valve-like stenosis, with expiration partially blocked; (4) complete stenosis with atelectasis.

The author stresses especially the value of bronchography, bronchoscopy, and tomography in differentiating between bronchial adenoma and pressure from extrabronchial tumors. He regards the appearance of an evenly outlined rounded mass partly within the lumen and partly external as very strong evidence of bronchial adenoma. Other benign tumors, such as fibroma, lipoma, osteochondroma, and neurofibroma, are rare. By bronchoscopy a biopsy specimen is sometimes obtainable and may be the final means of establishing the diagnosis.

Treatment depends upon the size, position, and duration of the condition. Endoscopic removal is mentioned, and may be tried if the mass is totally within the bronchus and no other changes are present. This procedure, however, is usually regarded as inadequate, and recurrence is the rule. Radical operation is the method of choice, especially if other changes are present.

Ten roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Early Detection of Bronchiogenic Carcinoma. Donald L. Paulson and Robert R. Shaw. J. A. M. A. **146:** 525–529, June 9, 1951.

The authors reviewed 362 cases of bronchogenic carcinoma seen by them over a period of three and one-half years. Fifty per cent were regarded as inoperable when first seen. Clinically, another 20 per cent were considered inoperable at exploration. In only 30 per cent was resection possible. A review of the histories revealed that there was an average lapse of five months from the onset of symptoms until the patient sought medical advice. Of greater significance, however, was the fact that another six months elapsed before the correct diagnosis was made. Thus a total of eleven months was lost, on an average, before suitable treatment could be applied.

The authors believe that several factors contribute to the delay in detecting bronchogenic carcinoma. These include: (1) delay by the patient in consulting a physician; (2) lack of appreciation by the medical profession of the increasing prevalence of bronchial carcinoma; (3) erroneous diagnosis as atypical pneumonitis or unresolved pneumonia.

The authors estimate that 40 per cent of patients having bronchogenic carcinoma are inoperable when they are first seen by a physician. This leaves about 60 per cent in whom an early diagnosis may make a cure possible. At present, as suggested above, only 30 per cent have the opportunity for a possible cure.

The symptoms include cough, chest pain, weight loss, dyspnea, fever, recurrent respiratory infections, wheezing, and hoarseness. Cough is the most important symptom and persists throughout the course of the disease.

The roentgen examination is the most valuable method of early detection of bronchogenic cancer. The neoplasm itself may not be visualized, but its effects are seen as areas of obstructive pneumonitis. The x-ray appearance is variable, depending upon the location of the tumor in relation to the bronchi. The appearance may be that of a lobulated mass growing out of the hilus or a discrete round or oval density in the parenchyma. Tumors arising in the extreme periphery may not cast a shadow on the roentgenogram, although this location is fortunately uncommon.

Specific methods of diagnosis include bronchoscopy, lung aspiration or needle biopsy, and exploratory thoracotomy. The authors believe that bronchoscopy followed by exploratory thoracotomy is the method of choice, with aspiration biopsy limited to those cases in which thoracotomy is contraindicated.

Periodic chest examinations and a high index of suspicion on the part of the physician are urged as means to further the cause of early detection of bronchogenic carcinoma.

Seven roentgenograms. O. W. DOYLE, M.D.
University of Michigan

Treatment of Non-Tuberculous Spontaneous Pneumothorax. Etienne Bernard and Andre Meyer. Dis. of Chest **19:** 641–651, June 1951.

Non-tuberculous spontaneous pneumothorax is more common than tuberculous pneumothorax. The authors

have had the opportunity of treating 100 cases. Although the condition is usually benign, active treatment is sometimes indicated, as in relapsing or chronic pneumothorax and pneumothorax with acute asphyxia.

The operative indications are dependent upon the roentgenologic and pleuroscopic observations. The authors do not usually resort to thoracotomy, since diffuse emphysematous blebs, demonstrable with the pleuroscope, are common. In such cases they resect adhesions and produce pleural symphysis by talc insufflation. Where x-ray examination and pleuroscopy show a single voluminous vesicle or air cyst, or a few such lesions, thoracotomy is performed. Localized lesions are usually removed by lobectomy. Decortication may be necessary in chronic cases with a markedly thickened pleura. Thoracoplasty is indicated in some cases, especially to avoid hyperexpansion of the remaining lobe after exeresis.

Seven roentgenograms. THOMAS S. LONG, M.D.
University of Louisville

Maxillary Sinusitis and the Post-Sinusitic Lung Syndrome in Radiological Practice. H. H. Weber. Schweiz. med. Wchnschr. **81**: 207–210, March 3, 1951. (In German)

The author calls attention to the fact that maxillary sinusitis is frequently undiagnosed. The only clinical symptom may be a chronic cough. If the chest roentgenogram in such cases is negative, the diagnosis of a nonspecific pharyngo-tracheo-laryngo-bronchitis is made and the patient is treated accordingly. If, however, the underlying cause of this chronic cough is a sinusitis, lung symptoms will be progressive and lead to the chracteristic picture of the "post-sinusitic lung syndrome." The roentgenogram will then reveal enlarged hili, accentuation of the bronchial markings, small peribronchial infiltrations, and occasional pleuritic involvement. Some cases have been regarded as tuberculosis and many patients have been mistakenly sent to tuberculosis sanatoria.

Weber recommends that in fluoroscopy of the chest the sinuses be included, particularly the maxillary sinuses. During fluoroscopy the patient should bend the head backward about 20 degrees.

Of 1,000 chronic coughers, 25 per cent were found to have a chronic sinusitis, confirmed roentgenographically.

Six roentgenograms.
EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

On the Differential Diagnosis of Transient Lung Infiltration with Eosinophilia (Loeffler's Syndrome). A. F. Essellier and B. J. Koszewski. Schweiz. med. Wchnschr. **81**: 247–250, March 17, 1951. (In German)

The authors report briefly 5 cases: a lung infiltration of unknown etiology, two aspiration pneumonias, a lobar pneumonia, and an infarct pneumonia, in which increases of 8 to 16 per cent of eosinophilic cells were observed, usually a few days after the disease had reached its peak. All patients had received procain penicillin in oil suspension.

Intramuscular administration of drugs in an oil suspension may give rise to an increase in the eosinophilic count of the blood. Whenever lung infiltration is present, such a resorptive eosinophilia may be suggestive of the Loeffler syndrome. Of patients in whom penicillin in oil had been given for non-pulmonary diseases about 50 per cent showed an eosinophilic reaction. The maximum increase in the eosinophil count was usually seen in the third week after injection. This observation was also confirmed by animal experiments.

Because of the different prognosis and therapy, the early recognition of this pseudo-syndrome is essential.

Five charts. EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

A Case of Intralobar Sequestration of the Lung Associated with an Abnormal Pulmonary Artery. C. McDowell, Douglas Robb, J. R. Hinds, and Rowan Nicks. Brit. J. Surg. **39**: 87–91, July 1951.

The association of an anomalous artery arising from the thoracic aorta with sequestration of a portion of the right or left lower lobe has several variations. The study of Pryce, Holmes Sellors, and Blair (Brit. J. Surg. **35**: 18, 1947. Abst. in Radiology **50**: 846, 1948) had familiarized the authors with this anomaly, and they made a tentative diagnosis in their own case before surgery.

The patient was an 8-year-old boy in whom an abnormal vessel arose from the aorta opposite the body of the ninth thoracic vertebra, and entered the base of the right lower lobe. Its distribution was confined to the sequestrated posterior basal segment. The sequence of radiologic features and their explanation by the authors was as follows: (1) a density at the right base caused by the sequestrated segment; (2) a gradual increase in the size of this density, probably due to distention of the blind bronchial tree by accumulated mucus; (3) an acute infection of the lower lobe which by contiguity spread to the sequestrated segment; (4) a spontaneous pneumothorax as a complication of the infection (the first sign of illness); (5) a fistulous communication between the normal bronchial tree and the bronchi of the sequestrated segment, as a further complication of the infection, accounting for air-containing cyst-like areas observed in the right lower lung field and for a productive cough. With resolution of the infection in the contiguous lung, the size of the lesion was reduced. The final situation was that of a cystic, suppurative condition confined to the posterior basal segment of the right lower lobe. Bronchography showed no filling of this area.

A right lower lobectomy resulted in an uneventful recovery. Although the fistulous connection with the ectopic lung segment was not shown bronchographically, its presence was demonstrated in the resected specimen.

Ten roentgenograms. DAVID D. ROSENFELD, M.D.
Fontana, Calif.

Pulmonary Arteriovenous Aneurysms and Their Relation to Osler's Disease. Chr. Hedinger, W. H. Hitzig, and C. Marmier. Schweiz. med. Wchnschr. **81**: 367–374, April 21, 1951. (In German)

Pulmonary arteriovenous aneurysms are frequently associated with Osler's disease and other vascular malformations. The authors describe a typical case.

A 46-year-old man was admitted to the hospital because of arterial bleeding from a tongue ulcer and subsequent severe anemia. The examination disclosed a telangiectasia hemorrhagica hereditaria, with cyanosis, polycythemia, and clubbing of the fingers and toes. The heart size and the blood pressure were within normal limits. Radiologically, Müller and Valsalva tests

demonstrated a pulmonary arteriovenous aneurysm. Two months after admission jacksonian attacks developed, with hemiplegia on the right. Death ensued three weeks later. Autopsy revealed a pulmonary arteriovenous aneurysm in the left lower lobe, with two communications. The right side of the heart showed slight enlargement.

The general symptoms of pulmonary arteriovenous aneurysm are weakness, decrease of functional capacity, and such cerebral symptoms as dizziness, unconsciousness, and transient hemiplegias. Radiographically, the aneurysm is seen as a more or less distinct rounded shadow. Afferent and efferent vessels connect it with the hilus. The aneurysm may be found in any lobe, but is usually located in the middle or lower lobe and near the heart. The walls are thin and elastic. The blood transport depends on the intrathoracic pressure, as can be demonstrated with the Valsalva and Müller tests. The authors recommend kymography, which should be done in two vertical planes. For the localization of the lesion, tomograms should be used. "In such cases," the authors state, "American investigators use angiocardiography, but the published pictures show that the gain in contrast over the common x-ray film (excepting tomography) should not be overestimated."

Pathologically, the aneurysms are anastomoses between an artery and vein; they have a very thin wall consisting of connective tissues without smooth muscle and elastic fibers, while the internal coat is endothelial. Arteriovenous aneurysm could be defined as a vascular malformation, but the normally present capillary bed is missing. The nature of the connection between Osler's disease and arteriovenous aneurysm and malformation of other vessels is not clear.

Eleven illustrations, including 6 roentgenograms.

ILONA D. SCOTT, M.D.
VA Hospital, Chamblee, Ga.

Bronchiectatic Bronchiolitis. A. Omodei Zorini and Luigi Pigorini. Dis. of Chest. **19**: 658–667, June 1951.

According to the authors, bronchiectatic bronchiolitis has the following characteristics: (1) a dry bronchitic state, generally dating from childhood or early youth, without fever, asthenia, depression, or presence of tubercle bacilli in the sputum; (2) frequent and recurrent hemoptysis, with or without acute or subacute bronchopneumonic foci; (3) fine, small bubbling râles, subcrepitant on both expiration and inspiration, more evident after cough, and located along a two-inch strip above the inferior posterior margin of one or both bases. This last is a constant finding on physical examination, unchanged even after several years.

Roentgenologic examination of the chest does not reveal sufficient evidence to justify the tentative diagnosis of common bronchiectasis. The diseased basilar areas of the lungs may present a quite normal picture, or there may be a slight alteration of the pattern of the markings. At times there is some emphysema of the bases. Bronchography shows no marked bronchial alterations. There are, however, mild cylindric dilatations, in a "rosary" or "small club" shape, affecting the most distal branches of the bronchial tree. The bronchioles are not as a rule uniformly increased in caliber but present varicoid and nodulated shapes. There is an associated slow and anomalous filling of the alveoli. The normal "foliage" pattern is lost and one sees "ball," "mulberry," or "ink-blot" groupings, made up of a great number of punctiform elements.

As a general rule, therapy is unnecessary in the free periods and is restricted to hemostatic and antibiotic treatment in the acute phases. When hemoptyses occur at frequent intervals, one should try to modify the local condition and reduce the danger of bronchial hemorrhage. In such cases excision of the phrenic nerve may be appropriate. In more advanced cases lobectomy or pneumonectomy may be indicated.

The authors state that the prognosis of this disease is relatively good. Generally speaking, it is static and the hemoptyses are not a cause for concern. The real danger lies in the possibility of a mistaken diagnosis of pulmonary tuberculosis.

A case is reported and 4 roentgenograms are reproduced.

WILLIAM H. SMITH, M.D.
University of Louisville

The Roentgen Picture after Lobectomy and Pneumonectomy. A. Linder. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 648–659, June 1951. (In German)

During the past few years the indications for lobectomy and pneumonectomy have definitely increased. These operations are now being done for tumor, bronchiectasis, tuberculoma, and lung cysts. Operative mortality, within the first three weeks, varies from 18 to 25 per cent. The author presents a summary of 10 cases observed following lobectomy and 7 following pneumonectomy, with particular reference to the intrathoracic changes observed roentgenologically.

Pneumonectomy: Shortly after operation there is very rapid fluid development on the operated side. Due to intrathoracic pressure changes, the mediastinum may be slightly displaced toward the side of the normal lung; later toward the operated side. The remaining lung as yet shows no increased transparency, but the hilar and vascular markings are considerably increased, due to engorgement secondary to the change of pressure. The diaphragm on the operated side is not visible and there is as yet no change in the level of the diaphragm on the opposite side. Subcutaneous emphysema is often present.

Two to three weeks after operation exudate has gradually filled more and more space on the operated side. Fibrin is thrown down, causing mottling and striping on the x-ray film. Sometimes multiple fluid levels are seen. The mediastinum shows gradual displacement toward the side of operation. There is as yet little change in the general appearance of lung aeration or position of the diaphragm. An occasional case will show slight widening of the heart shadow.

After one to two months there is further increase in fluid and the density on the x-ray film. Mediastinal displacement toward the operated side is more marked. Increased transparency of the remaining lung now becomes visible and the diaphragm is noted at a lower level. Hilar and vascular shadows assume a sharper appearance due to the contrast with the over-aerated lung. Subcutaneous emphysema has usually disappeared at this time.

Six to twelve months after pneumonectomy, opacity extends over practically the entire operated lung field. The shadows of the heart and mediastinum are sharply deviated to the opposite side and often completely lost within this opacity. The opposite lung shows marked transparency; vessel markings are intensified and very sharp. The diaphragm on the unoperated side is depressed; on the operated side the diaphragm shadow is usually lost within the general opacity but, when

recognized, is at a higher level. Intercostal spaces are narrowed on the opposite side. No changes have been observed in the vertebral bodies.

Lobectomy: Shortly after operation a small amount of fluid forms in the operated pleural space, but the remaining lung lobes expand to fill up this space very quickly. The opposite lung appears normal in all respects and there is no change in the diaphragmatic levels or any deviation of the mediastinum.

At two to three weeks there is a slight to moderate increase in density in the lower thorax on the operated side due to fluid. The adjacent lobes on the same side show some measure of increased transparency. Very seldom is there subcutaneous emphysema. The hilar and vascular structures bilaterally appear within normal limits.

One to two months after operation little or no increase in fluid is seen, but pleural thickening and bands have formed, showing some measure of increased density on the x-ray film. No change is apparent in the heart size. The diaphragm often appears slightly raised on the operated side but is always normal on the opposite side.

At six to twelve months there is increased opacity in the base, largely due to pleural adhesions. Increased transparency of the lobes is present on the operated side, due to filling in of the space resulting from the operation. Occasionally there is observed very slight mediastinal displacement to the operated side. Intercostal spaces of the operated side are not appreciably diminished. No changes are apparent in any of the vertebral bodies.

Eight roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Serofibrinous Interlobar Pleurisies. P. Pruvost, Teyssier, Isorni, Lemercier, Gosset and Cellerier. J. franç. méd. et chir. thorac. **5:** 401–420, 1951. (In French)

Seven patients who had serofibrinous interlobar pleurisy were studied. In each instance the patient complained of initial pain, more or less intense, accompanied by fever and cough without expectoration. A chest roentgenogram usually reveals an opacity with convex borders, as compared with the retractile opacity seen in inflammatory segmental lesions or atelectasis. A lateral projection will often clarify a misleading frontal view. At times the interlobar opacity assumes a pseudotumoral aspect. At other times it may be band-like, spindle-shaped, or triangular. Infarcts, cardiac decompensation, or tuberculosis may be the underlying cause.

Seventeen roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

Rationale of the Modern Diagnostic Approach to Mediastinal Tumors. Osler A. Abbott. J. Kentucky M. A. **49:** 197–209, May 1951.

An extensive discussion is presented, summarizing the diagnostic methods available to meet the problem presented by tumors of the mediastinum. Detailed charts covering the divisions of the mediastinum and their constant and inconstant contents, types of mediastinal tumors, and types of paramediastinal masses are included.

The importance of a good case history and physical examination is stressed. X-ray investigation is considered the major factor in the evaluation of these tumors. This should include a combined postero-anterior and lateral projection and a very thorough fluoroscopic examination. The use of the barium swallow is also necessary not only in the upright, but in the flat and Trendelenburg positions.

Laminagraphy is becoming of increasing importance in the experience of the author, and the need for the use of air and diodrast as contrast media is decreasing. The use of diodrast in venography and angiocardiography, however, still has a definite and important place in the study of mediastinal and paramediastinal masses.

The use of "diagnostic x-ray therapy" is criticized and condemned. The author further feels that as greater experience is achieved and greater interest evolved in the problem of mediastinal tumors, there will be less need for "exploratory" thoracotomy or "exploratory" x-ray therapy in dealing with these lesions.

Ten tables. FRANK T. MORAN, M.D.
Lancaster, Penna.

Angiocardiography in Congenital Heart Disease. Anaesthesia and Technique. D. M. Carnegie. Brit. M. J. **1:** 1230–1233, June 2, 1951.

Challenging the statement of Kreutzer *et al.* (Brit. Heart J. **12:** 293, 1950. Abst. in Radiology **56:** 908, 1951) that angiocardiography is "simple and harmless," the author reports 4 deaths in a series of 172 cases. He describes his method of preoperative preparation, anesthesia, and technic of injection, all of which seem to be in accord with usual practice.

Preoperatively, sensitivity tests are given for the opaque medium (diodone) and quinidine. Quinidine is used before injection of the medium to prevent arrhythmias. Barbiturates and atropine are given rectally for sedation and to insure a dry airway.

For general anesthesia, which is usually required in children under twelve, cyclopropane and oxygen are used, with added ether. The cyclopropane mixture allows plenty of oxygen and the ether prevents bronchospasm. Use of an endotracheal tube is recommended, although one was not used in this series.

As soon as the cannula is inserted in the vein, procaine solution 0.2 per cent is administered by drip method to decrease cardiac irritability. Continuous EKG tracings and blood pressure readings are taken for a time before the diodone is injected, for fear of a procaine reaction. The injection is done rapidly and oxygen given afterward for three hours or more, as necessary. The anesthetist stays with the patient until consciousness is regained. The first ten to fifteen minutes after the injection is the critical time so far as fatal reactions are concerned.

Suction apparatus is kept at hand, since anoxia cannot be tolerated by these patients. Cardiac stimulants are also kept ready for use, as well as instruments for exposing the heart for massage in case of arrest.

Three of the author's patients died on the operating table and 1 immediately after return to the ward. In going over the histories of the fatalities a sign of unfavorable prognosis was found: this was the preoperative occurrence of attacks of cyanosis or unconsciousness. All four patients who died had suffered from such attacks, as had a fifth child in whom cerebral anoxia developed. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

The Syndrome of Taussig and Bing. O. Bayer. Schweiz. med. Wchnschr. **81:** 558–560, June 9, 1951. (In German)

The syndrome of Taussig and Bing is characterized by the following three morphologic criteria: (1) The aorta takes its origin from the right ventricle and therefore receives blood only from the right ventricle. (2) The pulmonary artery takes its origin from an area of the heart overriding a defect high in the ventricular septum and receives blood from the right ventricle as well as from the left. (3) There is marked hypertrophy of the right ventricle.

The clinical findings are usually a severe cyanosis, existing from birth, clubbing of the fingers, and an enlargement of the heart with systolic murmurs over the base. Prominence of the pulmonary conus and an increase in the lung markings are demonstrable roentgenographically. The kymogram reveals increased pulsation of the hilar regions. The EKG shows a right axis shift. The oxygen saturation of the arterial blood is deficient. Differentiation from the Eisenmenger complex is possible only through catheterization of the heart, which shows a higher saturation of oxygen in the pulmonary artery than in the femoral artery. The pressure in the pulmonary artery and the right ventricle is greatly increased.

The author presents the case of a 24-year-old man with a typical syndrome of Taussig and Bing. The diagnosis was established by heart catheterization. The work-up of the case is excellent, and the paper should be read in the original by those interested in this congenital anomaly.

Four illustrations, including 2 roentgenograms.

WM. A. MARSHALL, M.D.
Chicago, Ill.

Acute Benign Pericarditis. Morton G. Brown. New England J. Med. **244:** 666–669, May 3, 1951.

The inclusion of the word "benign" in the title is highly justified by the 7 case histories which the author presents. These cases were selected from a total of 13 as illustrating the main features of acute benign pericarditis.

The diagnostic criteria are tabulated as follows:

	No. of Cases	Duration
Precordial pain	13	Hours to days
Pericardial friction	10	Hours to weeks
Electrocardiographic changes	13	2–12 weeks
Enlarged cardiac shadow	8	1–8 weeks
Benign course and complete recovery	13	

Four roentgenograms; 2 electrocardiograms.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Aneurysm of the Cardiac Apex in a Child. J. Papillon, J. Bret and P. Marion. J. de radiol. et d'électrol. **32:** 656–657, 1951. (In French)

A 7-year-old child was admitted to the hospital because of calcification noted at the cardiac apex during fluoroscopy. Of five siblings, one sister had died of the tetralogy of Fallot at the age of eighteen months. The patient had been born at term, and the mother had suffered no eruptive disease during pregnancy. There had never been any cyanosis. At the age of five years a cardiac murmur was discovered. The child had suffered the usual childhood diseases, except scarlatina.

Examination revealed normal development, prominent external jugular veins, a regular heart rate of 84, a "banal" mid-systolic apical murmur, and a venous pressure of 18 cm. of water. At fluoroscopy calcification was noted in the endocardial portion of a bulge in the cardiac apex. An electrocardiogram revealed changes suggesting an apical infarct. During angiocardiography a roentgenogram taken five seconds after the injection of contrast medium confirmed the presence of an aneurysm of the cardiac apex.

Three roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

The Heart in Progressive Muscular Dystrophy. Jacob Zatuchni, Ernest E. Aegerter, Lyndall Molthan, and Charles R. Shuman. Circulation **3:** 846–853, June 1951.

A case of progressive muscular dystrophy with cardiac involvement in a young Negro is reported. The presenting problem was cardiomegaly and congestive heart failure. It was not until compensation was achieved that the underlying myopathy became apparent.

Roentgenographic examination of the chest revealed increased bronchovascular markings of central distribution indicating pulmonary congestion. There was notable enlargement of the heart, predominantly of the left ventricle. Left auricular enlargement was demonstrated by the double shadow within the right heart border and by displacement of the barium-filled esophagus.

In a detailed review of the literature the authors state that the result of x-ray examination of the heart was noted in 25 instances. The examination was negative in 15 of these. In one the size of the heart was indeterminate; in another the cardiac silhouette was "ball-shaped." In the others the heart was found to be enlarged, either slightly or in all diameters. In one patient, the esophagus was slightly displaced by an enlarged right auricle. A kymographic study was done in this patient, and small excursions were observed.

One roentgenogram; 3 photomicrographs; 1 electrocardiogram.

THE DIGESTIVE SYSTEM

Esophageal Fibromyoma Associated with Diverticulum. Robert M. Hoyne and J. C. T. Rogers. Am. J. Surg. **81:** 592–594, May 1951.

The authors report a case of fibromyoma of the lower end of the esophagus associated with a diverticulum, in a 44-year-old white woman whose only symptom was occasional epigastric heaviness on overeating. The tumor with the diverticulum was discovered during a routine fluoroscopic and roentgenologic examination of the upper gastro-intestinal tract; both were removed surgically, and the patient made an uneventful recovery.

Benign tumors of the esophagus are rather rare. They are generally divided into two groups: those arising from the mucosa or submucosa and those having their origin from the muscular layer of the esophagus. The mucosal tumors grow into the lumen and may produce obstructive symptoms, dysphagia, epigastric or substernal distress, regurgitation, or singultus. Polyps are the most common mucosal tumor, although papillomas, fibromas, lipomas, adenomas, cysts, and

myxofibromas are seen. The extramucosal tumors are most commonly myomas, although neurofibromas may also occur in this location. The most frequent symptoms are substernal or epigastric distress, cough, and intermittent dyspnea. These tumors rarely cause dysphagia. They may produce no symptoms.

Diverticulum associated with benign tumor of the esophagus is decidedly uncommon. In the case recorded here, the diverticulum is believed to have resulted from traction of the intramural tumor upon the mucosa.

Since malignant degeneration has occurred in benign esophageal tumors, surgical removal is advised.

One roentgenogram; 1 photograph: 2 photomicrographs.

THOMAS R. HEPLER, M.D.
University of Pennsylvania

Esophageal Changes in Epidermolysis Bullosa Hereditaria Dystrophica. H.-G. Meyer-Krahmer. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 425–426, April 1951. (In German)

An esophagram in a 30-year-old woman with dystrophic bullous epidermolysis disclosed a narrowing of a distal segment of the esophagus measuring about 3 cm. in length. The same picture was seen nine months later. The author tries to explain the original finding on the basis of an acute process with bullae formation, while the second finding, nine months later, he attributes to fibrosis and atrophy as the end-result of the disease.

Two roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Complete Obstruction of the Esophagus Following Serutan® Ingestion. C. L. Hinkel. J. A. M. A. **146**: 1129–1131, July 21, 1951.

Serutan is a bland granular hygroscopic substance, widely used for constipation. Apparently, it owes its laxative properties to its gelatinous, spongy character and its ability to absorb and retain liquids, with a corresponding increase in bulk. A case of complete obstruction in the lower third of the esophagus, presumably resulting from the ingestion of dry serutan followed by an insufficient quantity of fluid, is reported. The typical roentgenologic characteristics of such an impaction were observed. The inferior end of the barium column in the esophagus outlined a smoothly rounded mass, and in the erect position some of the barium tended to surround the mass, producing the typical inverted meniscus sign frequently associated with meat impaction. The cohesive material was removed with great difficulty through the esophagoscope.

Mercury Lost in the Gastrointestinal Tract. Report of an Unusual Case. Meyer O. Cantor. J. A. M. A. **146**: 560–561, June 9, 1951.

Early in the 19th century numerous therapeutic properties were ascribed to metallic mercury in overcoming bowel obstruction. These were attributed to the fluidity and weight of the heavy metal, which was supposed literally to force its way through the obstructing process. This form of treatment fell into disrepute about the middle of the century, after Dujardin-Beaumetz (Disease of Stomach and Intestines, William Wood & Co., 1886) observed that the mercury did not pass down the gastro-intestinal tract *en masse* but became finely divided into small particles which could not exert any pressure upon the obstructive process. However, a useful objective was attained. The way was paved for the subsequent introduction of mercury into the end of a decompression tube.

A case confirming the accuracy of Dujardin-Beaumetz's observations is reported. The patient was a 35-year-old woman with a tubo-ovarian abscess. During surgical treatment, the colon at the rectosigmoid was opened. Despite massive doses of penicillin, phthalylsulfathiazole and streptomycin prior to and after operation, pelvic peritonitis developed. Four fecal fistulous tracts appeared in the next four weeks, one opening over McBurney's area, one below the umbilicus, one above the pubis, and one in the vagina. A mercury-bearing intestinal decompression tube was passed to treat the paralytic ileus resulting from the intra-abdominal inflammatory process. The balloon was improperly tied off and all of the mercury escaped within the gastro-intestinal tract. Roentgenograms taken soon thereafter showed large masses of metallic mercury. Seven days later the mercury was seen to be finely divided into particles which beautifully outlined the entire colon as effectively as though barium sulfate had been given. Only two small masses of mercury remained intact. A barium enema study disclosed a complete obstruction at the rectosigmoid. The fistulous tracts began just above the point of obstruction, exactly at the spot at which the dispersion particles of mercury and the barium met. On the twentieth day, in order to be certain that the fistulous tracts had their origin at the rectosigmoid, a radiopaque catheter was passed through one of them and 100 c.c. of a very dilute barium suspension was injected. The entire right, middle, and left colon up to the rectosigmoid was visualized, but none of the intestinal tract below the rectosigmoid. Only a small amount of mercury remained; from its position it would appear that it had found its way through the vaginal fistulous tract and through the tract in McBurney's area. During the next four weeks, globules were excreted through the fistulous tracts from time to time. On the twenty-second day a defunctionizing colostomy was done to divert the fecal stream. The tracts then began to close within a week and within two months all four had completely closed.

This case shows that fistulous tracts do not necessarily persist because of the presence of metallic mercury within the bowel. To cause such a tract to persist, the mercury must become trapped within it and there act as a foreign body.

Three roentgenograms.

Lipomas of the Gastrointestinal Tract. Kenneth W. Warren and Frederick H. Brandenburg. S. Clin. North America **31**: 743–752, June 1951.

Lipomas of the gastro-intestinal tract are relatively uncommon. The authors report a series of 11 cases, 6 of which produced significant symptoms.

Pathologically, lipomas are well differentiated tumors, usually solitary. They are commonly rounded, but 2 of the authors' cases were characterized by diffuse infiltration. They may be pedunculated or intramural. The overlying mucosa tends to ulcerate.

Clinically, these tumors may (1) cause interference with the normal pattern of gastro-intestinal motility, (2) produce simple mechanical obstruction, (3) incite intussusception, and (4) cause varying degrees of hemorrhage, ulceration, infarction, or gangrene.

Roentgenograms may reveal a smooth encroachment on the gastric lumen, and study of the films may show the tumor to be intramural. In the colon, in the absence of intussusception, lipomas frequently have a smooth polypoid appearance and may thus be confused with adenoma.

Treatment is surgical.

One roentgenogram; 2 photographs.

I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Congenital Intrinsic Obstruction of the Stomach and Duodenum in the Newborn. Clifford D. Benson and John J. Coury. Arch. Surg. **62**: 856–865, June 1951.

While notable advances have been made in the reduction of mortality in acute intestinal obstruction in adults, a similar reduction has not occurred in the newborn. In the latter group one must deal with factors not present in the former: prematurity, which is the direct cause of half the deaths in the first week, associated anomalies, and the fact that most of the obstructions are complete and produce marked changes in physiologic balance.

Intrinsic duodenal obstruction occurs in the second or third month of fetal life, when the intestine changes from a solid cord to its final form with a lumen lined with well defined epithelium. Failure of this process to develop normally results in stenosis, atresia, or an obstructing diaphragm.

The authors of this article report their experience with 1 case of intrinsic obstruction of the stomach and 10 cases of intrinsic obstruction of the duodenum.

The case of intrinsic obstruction of the stomach, the second to appear in the literature, occurred in an infant delivered of a hydramniotic mother. The child had swallowed a considerable amount of hydramniotic fluid and had a distended abdomen. She vomited all feedings and lost one pound in the first four days of life. A film showed gas in the stomach, but none in the bowel. At operation, on the sixth day of life, the entire gut was found to be devoid of gas and was collapsed. The stomach was opened and a diaphragm about one-eighth of an inch thick was discovered in the prepyloric area and was excised. The infant did poorly and on exploration, a week later, edema of the pylorus was found, causing obstruction to the gastric outlet. A gastroenterostomy was done at twenty-seven days, following which improvement was rapid. Two months later a barium meal passed entirely through the pylorus, none going through the gastroenterostomy opening. The infant was last seen at the age of fourteen months, when she weighed 25 pounds and appeared to be developing normally.

In their 10 cases of complete or partial obstruction of the duodenum the authors had 3 postoperative deaths, 2 in premature infants weighing less than 3 pounds. The obstruction was in most cases complete and was generally in the third portion of the duodenum.

If the obstruction is above the common bile duct, no bile will be vomited. If no gas is seen in the bowel on x-ray examination, the obstruction is considered complete and no barium is given. Where the obstruction is incomplete, a thin barium mixture may be given in order to identify the site of stenosis.

Adequate preoperative preparation and postoperative care are of paramount importance in these cases. The pediatrician and the surgeon must cooperate in restoring the proper electrolytic balance. The anesthesiologist is also an important factor in the successful outcome of the operation.

Thirteen roentgenograms.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Benign Giant Gastric Rugae Complicated by Submucosal Gastric Carcinoma. Report of Case. Milton J. Matzner, Adolph P. Raab, and Paul W. Spear. Gastroenterology **18**: 296–302, June 1951.

A 51-year-old male had been examined roentgenologically and gastroscopically over a period of ten years, showing giant gastric rugae suggestive of hypertrophic gastritis or possible neoplasm. On his final hospital admission, roentgenograms revealed gastric rigidity, with a filling defect along the proximal half of the lesser curvature of the pars media resembling a malignant infiltration, and a diagnosis of carcinoma was made. The resected stomach revealed a mucosal pattern which was greatly exaggerated, with prominent rugal folds increased in size and number. Microscopic examination showed the mucosal surface to be intact, but the submucosal and muscle layers were thickened and diffusely invaded with infiltrating carcinoma of an anaplastic type.

The authors were unable to establish any relationship between the submucosal carcinoma and the giant gastric rugae, and it was not possible to estimate the exact time of onset of the complicating neoplasm.

Giant gastric rugae usually offer no typical symptomatology. The presenting complaint is frequently upper abdominal pain, somewhat ulcer-like in character, but inconstantly relieved by the intake of food and alkalies. The roentgen findings are varied: localized irregular hypertrophic mucosal folds, wart-like granulation of the mucosal relief, or areas of stiffness and infiltration.

In the differential diagnosis, one must consider hypertrophic gastritis, polypoid carcinoma, lymphosarcoma, multiple adenomatous polyps, and less commonly leiomyosarcoma, Hodgkin's disease, and syphilis of the stomach. To this list must now be added a coexistent intramural gastric lesion, such as diffuse submucosal carcinoma of the linitis plastica type, as found in the case reported.

Gastritis may present a gastroscopic picture indistinguishable from carcinoma of the stomach. It is felt that a valuable aid in distinguishing between the two conditions is palpation of the abdomen when examining the interior of the stomach gastroscopically. If the lesion is pliable, it is more likely due to gastritis.

One roentgenogram; 3 photomicrographs.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Leiomyoma of the Stomach. Samuel F. Marshall and William A. Meissner. S. Clin. North America **31**: 735–742, June 1951.

Leiomyoma is the most common tumor of the stomach. One of the authors (Meissner: Arch. Path. **38**: 207, 1944) found an incidence of 46 per cent in a series of 50 autopsies and Rieniets (Proc. Staff Meet., Mayo Clin. **5**: 364, 1930) reported the finding of one or more leiomyomas of the stomach in 32 of 200 necropsies.

These tumors occur more frequently in the pyloric third of the stomach and vary from 0.5 to 7.0 cm. in diameter. They are usually round to ovoid; some are

lobulated. Except for a few of the smaller ones, which are intramural, the tumors project into the lumen or out from the serosa, or both. Mucosal ulceration was noted in 4 of the present series of 19 cases; the ulcer is deeper than the usual peptic ulcer.

The clinical course depends on the size of the tumor, its site of origin in relation to the gastric orifices, and whether or not there is ulceration of the mucosa with hemorrhage.

Of the authors' 19 patients, 9 were operated on primarily for gastric neoplasm; in the others the tumor was found at laparotomy for other conditions. In 6 of the 9 operated cases, the correct diagnosis was made preoperatively by roentgen examination. The most characteristic finding is a circumscribed globular defect which tends to be within the lumen of the stomach. There are usually no associated changes in the blood count or gastric acidity. Hemorrhage in the form of hematemesis or melena was the presenting symptom in 5 cases, nausea and vomiting in 2 cases; in other cases epigastric pain was noted.

The authors feel that the possibility of sarcomatous degeneration is sufficient to require wide partial gastrectomy.

Three roentgenograms; 1 photograph; 1 photomicrograph.

I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Localized Walled-Off Gas Pockets due to Perforation Complicating Peptic Ulceration. Samuel M. Gilbert. Gastroenterology **18:** 313–314, June 1951.

Feldman (Gastroenterology **14:** 201, 1950. Abst. in Radiology **56:** 144, 1951) reported 5 cases of walled-off perforations involving the stomach or duodenum, in which a subhepatic or perigastric gas pocket could be demonstrated on the roentgen film. The author reports a similar observation.

The patient was a 53-year-old male who had had attacks of peptic ulcer pain for nineteen years. Examination of the stomach revealed a constant niche at the pylorus, with marked pylorospasm. In all the films a large pocket of air was seen in the subhepatic space, with a small layer of barium visible at the base of the air pocket. An air sinus was demonstrated from the site of the ulcer directly to the subhepatic space. A diagnosis of minute perforation of the pyloric ulcer was made, and confirmed at operation.

As in Feldman's cases, this patient had a long history of peptic ulcer, at first amenable to medical therapy, but finally becoming intractable.

One roentgenogram.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Congenital Abnormalities of Intestinal Rotation and Mesenteric Attachment—A Cause of Intestinal Obstruction in the Adult. Robert B. Brown and Donald Ross. Ann. Surg. **134:** 88–98, July 1951.

Abnormalities of intestinal rotation and mesenteric fixation cause intestinal obstruction in adults more frequently than is realized. Four types are discussed, with illustrative case reports: (1) sigmoid dolichocolon or megacolon, with obstruction due to a volvulus associated with an abnormally long mesocolon; (2) mesenterium commune, in which there is a common mesentery for the duodenum, small bowel, and right side of the colon, with volvulus formation; (3) mesenterium commune combined with failure of intestinal rotation; (4) right paraduodenal hernia, with the duodenum and small intestine trapped beneath the mesentery of the right colon. The roentgenogram in this latter instance is rather characteristic, showing the loops of small bowel in a well bounded zone "as though confined in a bag."

Twelve roentgenograms; 3 photographs; 3 diagrams.

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Pneumatosis Intestinalis. Review of the Literature with Report of 13 Cases. Ellen P. MacKenzie. Pediatrics **7:** 537–549, April 1951.

Thirteen cases of pneumatosis intestinalis are reported, 12 in infants between twelve days and one year of age and the other in a boy of six years. A review of these cases and of 32 additional cases in children recorded in the literature discloses that the condition occurs most frequently in patients whose general health is poor and is very often associated with congenital or acquired disease of the intestine; respiratory disease, usually infectious, frequently co-exists. In all of these cases the presence of the pneumatosis was discovered only at autopsy. The author believes, however, that with the aid of the typical roentgen findings, a clinical diagnosis is feasible and may be accomplished when the disease is more widely known. The roentgenograms show pneumoperitoneum and cysts.

The clinical picture and roentgenographic findings in pneumatosis in adults are reviewed. The most acceptable theories concerning the pathogenesis are discussed, including the possible relationship to infantile diarrhea.

Four illustrations, including 1 roentgenogram.

Generalised Scleroderma with Intestinal Involvement. C. Barrington Prowse. Lancet **1:** 989–991, May 5, 1951.

A case of scleroderma with widespread visceral lesions, all of which produced signs or symptoms and contributed to the fatal result, is presented. Particular stress is laid on the intestinal features of the case, first because death eventually resulted from paralytic ileus, second because the effects of scleroderma on the intestine have seldom been reported. In addition to increasing tightness of the skin, the patient complained of dysphagia. Roentgen examination revealed emphysema and chronic bronchitis with dense shadows at both bases, particularly the right. There was slight general enlargement of both ventricles; the aorta was unfolded and atheromatous. A barium swallow showed achalasia of the cardia and slight general dilatation of the esophagus, which was distended with air. At necropsy, characteristic changes were found at the lower end of the esophagus. A plastic peritonitis, with coils of bowel adherent to one another and to parietal peritoneum by fine adhesions, was also present. Histologic examination of the small intestine showed extensive round-cell infiltration of the submucosa and atrophy of all layers, with an increase in collagenous tissue.

Two roentgenograms; 2 photomicrographs.

Porphyria. A Cause of Nonspecific Small Intestinal Disturbance. Samuel H. Fisher and Robert R. Stanley. Am. J. Roentgenol. **65:** 882–885, June 1951.

Porphyria is a constitutional anomaly of pigment metabolism, characterized by remissions and exacerba-

tions. In addition to the idiopathic type there is an acute toxic type due to such agents as the barbiturates, lead, sulfones, and acetanilid, which probably act as precipitants in patients with the underlying metabolic disorder.

Porphyria presents a bizarre clinical picture of gastrointestinal and central nervous complaints. Abdominal pain, often cramp-like in nature, nausea, vomiting, obstipation, and jaundice may be seen. In most cases the picture is one of "acute surgical abdomen." Symptoms referable to the central nervous system range from the classic finding of an ascending Landry's paralysis to paresthesias, delirium with hallucinations, epileptic seizures, and coma. A characteristic feature is darkening of the urine on exposure to light.

A case is reported of a 23-year-old white male who complained of painful urination, low abdominal cramping pain, and pains in the arms and legs. These symptoms were of gradual onset and had been present for two weeks. Dark urine had been noticed. Roentgenograms of the intestinal tract revealed extreme small intestinal distention, without hypermotility. Urine of port-wine color, strongly positive for porphobilinogen, was passed on one occasion. Severe psychotic symptoms developed, necessitating the patient's discharge. Some four months later (five months after admission) he was symptom-free, and the small intestine appeared much more normal roentgenologically.

Five roentgenograms are reproduced, illustrating "an unusual degree of non-specific small intestinal neuromuscular disturbance," believed to be due to porphyria.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Unusual Case of Duodenum Inversum. Seán O'Beirn. Irish J. M. Sc., p. 293, June 1951.

A case of duodenum inversum of Feldman and Morrison's fourth type (Am. J. M. Sc. **200**: 69, 1940. Abst. in Radiology **36**: 640, 1941) is reported. This type, unlike the other three, is associated with congenital non-rotation of the intestine, the small intestine being on the right and the colon on the left. The roentgen examination showed the lower end of the second portion of the duodenum turning to right, then upward, then to left, and finally downward behind its second part, forming a perfect loop before continuing on to join the rest of the small bowel in the right abdomen.

One roentgenogram; 1 drawing.

Benign Duodenocolic Fistula. C. Sherrill Rife. Arch. Surg. **62**: 876–881, June 1951.

The case of benign duodenocolic fistula presented here is said to be the eighth recorded in the literature since 1885. In most instances the causative factor was perforation of an ulcer. Two cases were recently reported (Ogilvie: Ann. Surg. **131**: 899, 1950), in which the fistula was due to caseating tuberculous lymph nodes that had eroded into the duodenum and colon.

The author's patient was a man of 45, who complained of intermittent diarrhea for four years. He had six to eight stools a day and had occasionally noticed undigested food in the stools. There was no abdominal pain or other symptoms suggestive of ulcer.

A barium enema study revealed a filling defect in the hepatic flexure about 10 cm. in length. A film taken after evacuation showed some barium in the stomach and a fistulous tract which appeared to extend from the right transverse colon to the duodenum. X-ray examination two days later disclosed a normal stomach, deformed duodenal cap, widening of the second portion of the duodenum, and a fistulous tract extending from the junction of the second and third portion to the right transverse colon. Most of the barium did not pass through the tract but proceeded normally through the small bowel. The gallbladder functioned normally and there was no evidence of stone.

At operation a firm mass involving the duodenum and the transverse colon just distal to the cecum was resected and an end-to-end anastomosis was done between the ileum and transverse colon. The gross specimen showed small ulcers and chronic inflammation. The fistula was believed to be due to perforation of an ulcer in the second portion of the duodenum into the colon. The patient gained slowly but fifteen months after operation was in excellent condition.

Four roentgenograms; 1 drawing.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Prolapse of the Lower Lip of the Ileocecal Valve Into the Terminal Ileum. Leo G. Rigler and Elliott Lasser. Am. J. Roentgenol. **65**: 878–881, June 1951.

Although the ileocecal valve resembles the cardiac and pyloric sphincters in that it is situated at the junction of two intestinal segments of markedly different intraluminar caliber, its abnormalities have attracted far less attention.

Barium enema studies were done on a patient with a known history of four benign adenomas of the colon, removed surgically. At the time of the last operation there had been seen in the terminal ileum a smooth polypoid filling defect which could be displaced manually into the cecum. This was thought to represent a pedunculated polyp arising from the cecal mucosa, in contiguity to the ileocecal valve, and capable of prolapse through it. Three months later, examination showed a large mass of tissue about the valve but no prolapse. Because of the possibility that malignant change had taken place, the patient was explored, but though the terminal ileum and ascending colon were thoroughly palpated, there was no evidence of a growth, and cecotomy was not performed. Five months later, the defect was again seen on the roentgenograms, and the patient was again operated upon, a subtotal colectomy being done. Several small polyps were found. The ileocecal valve was markedly thickened and yellow and could readily be displaced proximally into the ileum or distally into the colon. Microscopic studies showed no mucosal abnormalities. Much loose areolar tissue lay beneath the mucosal surface, causing it to protrude at a considerable distance above the musculature.

It is believed that the force of the barium enema at the time of the initial study was sufficient to cause the thickened lower lip of the ileocecal valve to prolapse back into the terminal ileum, thus simulating a pedunculated polyp. Such an occurrence constitutes the opposite of herniation of the ileal mucosa into the cecum, as described in other reports.

While the condition described is abnormal, its only importance lies in the fact that its recognition may prevent unnecessary surgical procedures.

Six roentgenograms; 1 photograph.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Morphological-Functional Observations in Dolichosigmoid. Seventy Cases. Giancarlo Lischi. Radiol. med. (Milan) **37**: 445–457, June 1951. (In Italian)

The author presents his observations based on the study of 70 patients in whom the sigmoid was abnormally long. He states that 41 per cent of his patients presented clinical symptoms and emphasizes the importance of this anatomical variant in the production of volvulus and of partial obstruction. He also emphasizes the fact that pain in the right lower quadrant may be due to inflammation in the long sigmoid loop so that this condition may simulate an inflamed appendix.

Four roentgenograms; 10 drawings; 1 table.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Inadequacy of Routine Barium Enema for the Roentgenologic Examination of the Rectum. George Levene and Norman C. Veale. Am. J. Digest. Dis. **18**: 175–181, June 1951.

Roentgenologic examinations of the rectum and anus are not only of limited value but may actually lead to a false negative report. Large carcinomas of the sigmoid and rectum may not be recognized until obstruction is present. The authors criticize the radiologist for failing to develop a better technic for visualizing this area. They have devised a procedure in which the lower sigmoid and rectum are sprayed with a thin barium-water suspension, in the belief that, without the distortion incident to distention with barium, the area will be visualized under more normal conditions and that small lesions such as polyps and internal hemorrhoids will be more easily seen.

The rectum begins at the level of the third sacral vertebra as a continuation of the sigmoid and extends to the pelvic diaphragm, where it joins the anal canal. The rectosigmoid junction is slightly constricted due to the rudimentary sphincter of O'Beirne. The rectum is itself divided into an upper and lower ampulla. The mucosa of the upper ampulla is smooth, but is raised up in three semilunar folds called the valves of Houston, the lowest of which is the dividing line between the upper and lower ampullae. The mucosa of the lower ampulla is gathered into longitudinal folds between which are the crypts of Morgagni.

Lateral films of the rectum both before and after evacuation are useful in detecting the presence of disease. When the bowel is filled with barium, it lies close to the spine. When emptied, it normally falls forward. Failure to move is indicative of disease, as cancer, or adhesions from a previous operation.

Twenty-two roentgenograms.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Congenital Malformations of the Rectum and Anus, with Special Reference to the Treatment of Associated Fistulas. Ernest E. Arnheim. Am. J. Surg. **81**: 538–547, May 1951.

The author first reviews the embryology of the anorectal region so that the pathogenesis of its malformations may be better understood. A classification, previously offered by Ladd and Gross (Am. J. Surg. **23**: 167, 1934) is presented with a review of the literature giving the incidence of the types of congenital malformation of the rectum and anus. The four types described are: (1) a stenosis at the anus or at a point several centimeters above the anus; (2) an imperforate anus, the obstruction being membranous in character; (3) an imperforate anus, the rectal pouch ending blindly some distance above the anus (the most common); (4) a normal anus and anal pouch, the rectal pouch ending blindly in the hollow of the sacrum. Other anomalies are very commonly associated with malformations in this region.

The author presents a study of 18 cases of his own, all of which were in the third group. A fistula was present in 11 of these, and 3 patients had associated anomalies of the digestive tract.

These malformations are usually suspected because meconium has not been passed or has come through an abnormal opening. The diagnosis is confirmed by physical and roentgen examination. The roentgenograms should be made with the infant suspended head downward, with a radiopaque marker at the site of the imperforate anus. It has been suggested that the infant be suspended in this manner five to ten minutes before the examination is made. Errors are common during the first twenty-four hours because air has not yet reached the rectum and for this reason films during the second day are usually more accurate. If an external fistula is present, it may be outlined by the injection of radiopaque material and the site of entrance into the rectum will be demonstrated.

The treatment, ranging from a simple surgical procedure to a series of staged operations, depending upon the type of anomaly, is described. The results of these procedures are reviewed. They depend upon the type of anomaly and associated fistula, the condition of the patient, the presence of serious associated congenital anomalies, surgical judgment and technic, and preoperative and postoperative care.

It is felt that, with the exception of infants in poor condition due to prematurity or serious associated congenital anomalies, an early diagnosis and good surgical result may be anticipated.

Eight roentgenograms; 9 drawings; 4 photographs.

NORMAN J. WINSTON, M.D.
University of Pennsylvania

Stereoscopic Radiography in the Diagnosis of Anorectal Fistula. Louis J. Hirschman. Am. J. Surg. **82**: 83–85, July 1951.

Many so-called simple direct anorectal fistulae are said to *recur* after operation when actually the fistula *persists* because some side tracts or branches were never discovered, the diagnosis having been made by the insertion of a probe. The use of stereoscopic radiography after the injection of an opaque fluid or paste will prevent this diagnostic error and may save the patient multiple unnecessary operations and needlessly prolonged surgical treatment.

In the preparation of the patient for radiographic study it is important that the bowels be thoroughly emptied and cleansed, preferably by a warm enema containing sodium bicarbonate or sodium chloride in weak solution or by simple tap water. For a contrast medium, the author prefers an opaque paste such as bismuth paste (one part bismuth subnitrate to two parts of yellow petrolatum) to an oil such as lipiodol. A glass sinus syringe with a curved shank surmounted by a conical tip is filled with the paste, which has been heated to approximately 110° F., at which temperature it is fluid and easily injected. The patient is placed in the prone or left lateral position. If there is more than one

external opening, usually the largest or the one located most nearly in the right or left posterior quadrant is used for the injection. The tip of the syringe is placed against this external opening and the paste is slowly introduced. It will soon be seen emerging from one of the other external openings, if present, and usually from the anal aperture. If a considerable quantity of paste is injected before any appearance externally, it may be assumed that the paste is entering the rectal cavity from an internal opening or is reaching one or more cavities surrounding the bowel which are the remains of the parent abscesses.

All excess paste should be wiped gently from the rectal cavity and from the surrounding cutaneous surfaces before the roentgenograms are taken. Lateral and anteroposterior flat films, as well as stereoscopic exposures, should be made, and not infrequently a barium enema should be given after the first set of fistula films. This will aid in determining the location of fistulous cavities around the bowel above sphincter level. Internal sinuses or those which open only inside the anorectal canal are best injected under direct vision through an anoscope. In painful or sensitive conditions it may be necessary to relax the sphincter under regional or caudal anesthesia.

Two roentgenograms.

Acute Appendicitis, with Radiopaque Appendiceal Lithiasis. Eugene G. Laforet, John J. Greenler, and Edward J. O'Brien, Jr. Am. J. Roentgenol. **65**: 867–877, June 1951.

The presence of fecalithiasis in association with acute appendicitis is neither uncommon nor unimportant. It should be more often considered in the differential diagnosis of cases presenting acute abdominal symptoms in which the roentgenogram discloses a right lower quadrant opacity.

The authors report the case of a young man, acutely ill, with severe abdominal pain. The clinical impression was that "an intra-abdominal catastrophe had occurred, with secondary spreading peritonitis." The primary lesion was believed to be in the appendix, though a perforated peptic ulcer was regarded as a possibility. Roentgen examination revealed a dense, circumscribed, laminated shadow, measuring 1.8 × 2.0 cm., in the right lower quadrant overlying the crest of the ilium, 4 cm. distant from the tip of the nearest transverse process. It was thought to represent a radiopaque appendiceal fecalith which had probably ulcerated through the wall of an acutely inflamed appendix. At operation an obviously diseased appendix was discovered, and a large fecalith was found lying free in the colic gutter.

It is believed that fecaliths in the appendix are formed of inspissated fecal matter and are not opaque unless calcium salts have been deposited as the result of inflammatory reaction in the surrounding tissues. Intermittent deposition of calcium accounts for lamination. A calcified coprolith, or true calculus, is thought to be rare. However, there is a discrepancy in the reported incidence.

Roentgenologically a calcified fecalith is usually seen as a solitary shadow in the right lower quadrant, sometimes showing laminations. It varies in size from that of a pea to a bean, and is usually round or oval. Occasionally a non-opaque appendiceal fecalith is demonstrated by contrast study. The differential diagnosis includes any opacity which might lie in the same anatomical projection. A right ureteral calculus is the commonest source of confusion. Studies of the genitourinary tract will usually exclude this possibility.

If an appendiceal stone is found incidental to another examination, it affords a criterion whereby the patient's susceptibility to acute appendicitis may be judged. Many authors suggest prophylactic appendectomy. In any event, a person with a proved appendiceal calculus should be carefully followed as a possible subject for an attack of acute appendicitis.

Two roentgenograms; 2 tables, one of which presents details of the previously reported cases.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Lithiasis of Meckel's Diverticulum. Report of a Case. Alfredo R. Basile and Marcos Elfersy. Gastroenterology **18**: 287–289, June 1951.

There are only a few reported cases of concretions in Meckel's diverticulum. Seven of the patients had symptoms of appendicitis, and in the remainder the discovery of calculi was purely incidental to other pathological conditions, as carcinoma of the cecum and, in the authors' case, carcinoma of the sigmoid colon.

A man of forty-nine complained of pain in the right hypochondrium and iliac fossa, a heavy sensation in the hypogastrium, and alternating diarrhea and constipation, with periods of fever. He had had an appendectomy at the age of ten and a cholecystectomy for biliary lithiasis at thirty-one. A plain roentgenogram of the abdomen showed a stratified calculus, about 2 cm. in diameter, just above the upper border of the right iliac crest, though this position was not fixed. The stone was established by urography as lying outside of the urinary apparatus, and x-ray examination of the large bowel showed it to be adherent to the inner border of the cecum. This latter examination revealed narrowing of the sigmoid colon proved endoscopically to be due to carcinoma, which was presumably responsible for the patient's symptoms.

At laparotomy a Meckel's diverticulum was found, containing a single, stratified calculus, with all the microscopic characteristics of a biliary calculus. A calculus in Meckel's diverticulum must be differentiated from biliary lithiasis, renal lithiasis, phlebitis, and calcified lymph nodes. In the present case, location in a Meckel's diverticulum was supported by the circumstance that the patient had been previously cholecystectomized and the exclusion of a urinary calculus by urography.

Two roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Peritoneoscopic Cholangiography. Philip G. Keil and S. N. Landis. Arch. Int. Med. **88**: 36–41, July 1951.

Injection of radiopaque material into the gallbladder under peritoneoscopic vision is useful in problem cases in which history, results of physical examination, clinical course, outcome of liver function tests, and other types of cholecystography fail to establish a diagnosis. The technic consists of introducing a peritoneoscope into the peritoneal cavity and with it guiding a needle to the body or fundus of the gallbladder under direct vision.

With the needle in the gallbladder cavity, 15 to 40 c.c. of 70 per cent diodrast is injected, along with 5 c.c. of

1 per cent procaine hydrochloride. Air may also be injected to provide double-contrast studies. After removal of the peritoneoscope and needle, roentgenograms are taken immediately and at five and fifteen minutes. A fatty meal is then administered, and films are taken fifteen and thirty minutes later.

Occasionally a patient will experience pain, with rigidity in the right upper quadrant, as a result of parietal peritoneal irritation caused by traumatizing the peritoneum with the tip of the peritoneoscope. If diodrast is injected into the gallbladder wall, a chemical cholecystitis with severe constant pain in the right upper quadrant and vomiting may be produced. No more than a few drops of bile have been observed escaping through the needle hole. Usually none escapes. Bile peritonitis or fistula has not been encountered.

By peritoneal cholangiography the gallbladder, cystic duct, and common duct can be visualized in their entirety. The cystic duct is of variable length and 1.5 to 4.0 mm. in diameter. The common duct, also of variable length, is 2 to 8 mm. in diameter; the distal one centimeter is ordinarily tapered at its junction with the duodenum. Emptying time is variable. Dilatation of the cystic duct above 5 mm. and of the common duct above 8 mm. is indicative of obstruction.

This method of examination is valuable when oral and intravenous cholecystography fail.

Eight roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California

Congenital Absence of the Gall-Bladder: Cholangiography: Gall-Stone Solvents. A. J. H. Rains. Brit. J. Surg. **39**: 37–39, July 1951.

This report concerns a 61-year-old woman in whom operation for obstruction of the common bile duct revealed congenital absence of the gallbladder. The fossa of the gallbladder at the under-surface of the liver was represented by a deep fissure, and a membrane extended from the anterosuperior aspect of the first part of the duodenum to the porta hepatis. Many calculi were removed from the hepatic and common bile ducts. A cholangiogram obtained on the eighth postoperative day further demonstrated absence of the gallbladder but outlined the common bile-duct and hepatic radicals and a small cystic duct, which ended blindly.

The author reviews briefly the embryology of this anomaly and the literature concerning it. For cholangiography he used lipiodol and obtained anteroposterior and left lateral films. The latter view demonstrated the left hepatic duct more clearly.

Ether was used as a gallstone solvent postoperatively. Its use and dangers are reviewed.

One drawing, one roentgenogram.

DAVID D. ROSENFELD, M.D.
Fontana, Calif.

Papilloma of the Gallbladder. Francis A. Reynolds. Am. J. Surg. **81**: 589–591, May 1951.

The author reviews the literature of papilloma of the gallbladder and presents the only case observed in a series of 272 cholecystectomies performed at the Henry Heywood Memorial Hospital (Gardner, Mass.), 1944–49. The wide variation in the reported incidence of this condition—1.5 to 8.0 per cent of various gallbladder series—evidently stems from the variance of the criteria for diagnosis.

According to Ringel (Arch. f. klin. Chir. **59**: 161, 1899) the "true papillomas of the gallbladder are a framework of vascular connective tissue covered by a single layer of columnar epithelium. The tumor may be sessile or pedunculated, measuring from 1 to 5 mm. in diameter. Occasionally clear cells containing refractile neutral fat or cholesterol are found in the connective-tissue core."

The difference between a papillomatous and strawberry gallbladder is felt to be one of degree. The strawberry gallbladder is attributed to lipoid substances within swollen connective-tissue cells just beneath the epithelium. When villi become large and branched, they form papillomas. Histologically, a single villus of strawberry gallbladder and a small papilloma are indistinguishable.

The etiology of papillomas of the gallbladder is open to speculation. It is felt that infection may play an important role. The question of malignant change is regarded as highly problematic, but some cases have been reported.

Kirklin (Am. J. Roentgenol. **25**: 46, 1931. Abst. in Radiology **16**: 786, 1931) and Sosman (New England J. Med. **231**: 786, 1944. Abst. in Radiology **45**: 311, 1945) state that the diagnosis can be made radiographically with a high degree of assurance.

Two roentgenograms; 1 photomicrograph.

WILLIAM J. GRIPPE, M.D.
University of Pennsylvania

Annular Pancreas. A Report of Two Cases. Conde F. Conroy and George F. Woelfel. Surgery **29**: 902–906, June 1951.

The authors report 2 cases of annular pancreas diagnosed at operation, bringing the total of reported cases to 58. [For 2 additional reports see below.]

A 30-year-old male complained of epigastric pain of five years duration. Roentgen study of the gastro intestinal tract was negative except for an "out-pouching" of the anti-mesenteric border of the descending portion of the duodenal arch, with retention of the barium in that area. At laparotomy a hard, nodular, annular band of pancreatic tissue was found completely surrounding the second portion of the duodenum. This was incised anteriorly and the obstruction relieved. Three months later the patient was asymptomatic.

A 26-year-old female gave a history of recurrent right upper quadrant pain for several years, accompanied by nausea and vomiting and relieved by eructation. Barium meal studies showed a persistent narrowing in the second portion of the duodenum, but there was no retention. At surgery the duodenum was found to be encircled by pancreatic tissue at the junction of the first and second portions. Since it was difficult to free the pancreas from the duodenum, a gastro-enterostomy was performed to relieve the obstruction.

According to the most widely accepted theory, the annular pancreas is due to the failure of the ventral pancreatic anlage to rotate with the duodenum. The anomaly is not incompatible with a long life.

Roentgenograms of the two cases are reproduced, demonstrating partial block of the duodenum with dilatation of the first portion and notching in the second. Attention is called to the fact that, though this roentgenologic finding is characteristic of annular pancreas, a similar picture may be produced by a healed ulcer.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Annular Pancreas. J. R. Anderson and H. Wapshaw. Brit. J. Surg. **39**: 43–49, July 1951.

A 32-year-old female entered the hospital with symptoms suggesting acute cholecystitis and signs of obstructive jaundice. At surgery an annular pancreas was found, surrounding the second portion of the duodenum and causing partial obstruction of the common bile duct. Resection of a segment of the anomalous pancreas at the anterior surface of the duodenum resulted in relief of symptoms. Histologically the excised annulus showed acinar loss with replacement by fibrous tissue.

Postoperative upper gastro-intestinal studies at two and six weeks showed narrowing of the descending duodenum with delay in transit of barium. Three months after operation, however, there was a normal flow of barium into the jejunum. A postoperative cholangiogram revealed narrowing of the common duct at its distal end with dilatation of the bile duct above this. A small duct was noted to the right or posterior to the distal common duct. This was believed to represent the duct draining into the annulus.

The authors believe that the annular pancreas in this case was the seat of repeated attacks of subacute pancreatitis and that the jaundice observed on two occasions was due to compression of the common bile duct during more active phases of the pancreatitis.

The theories of origin of this anomaly are discussed. The authors favor the idea that the ring is the result of an abnormality in development of the ventral pancreatic anlage.

Five roentgenograms; 3 photomicrographs; 2 diagrams. DAVID D. ROSENFELD, M.D.
Fontana, Calif.

Annular Pancreas. B. J. Bickford and J. C. F. Lloyd Williamson. Brit. J. Surg. **39**: 49–52, July 1951.

A 25-year-old male complained of epigastric pain, vomiting, and anorexia for approximately three weeks before hospitalization. Repeated barium-meal studies revealed almost complete obstruction in the second portion of the duodenum near its junction with the first part, with distention of the stomach and duodenum proximal to this point.

Laparotomy disclosed an enlarged, firm, nodular pancreas, suggesting carcinoma. A ridge of hard tissue extended to the right, in front of, and around the second part of the duodenum and caused the obstruction. No biopsy is reported.

A posterior gastrojejunostomy resulted in complete relief of symptoms. At the time of the report, almost five years later, the patient remained in good health, leading the authors to the conclusion that they were dealing with chronic inflammation in an annular pancreas rather than a neoplastic process.

The literature concerning annular pancreas is reviewed, and treatment is discussed. Eighteen reported cases in which operation was done are listed.

Two roentgenograms; one diagram; two tables.
DAVID D. ROSENFELD, M.D.
Fontana, Calif.

HERNIA

Diaphragmatic Hernia: A Case Report. John R. Ross and Allen C. Johnson. Gastroenterology **18**: 448–450, July 1951.

The authors report a case of an obese 57-year-old woman who was entirely asymptomatic until she experienced sharp left chest pain while laughing. This was followed by occasional "gas" pains and incessant vomiting and cyanosis. There was no hematemesis.

The patient was hospitalized and barium meal examination disclosed a large hiatus hernia, with the fundus and antrum of the stomach in the chest. Three days after the onset of symptoms a Levin tube was introduced into the stomach, 1,000 c.c. of brown watery fluid were aspirated, and drainage was instituted. Subsequent roentgen examination showed the herniated stomach just anterior to the spine, indicating that the herniation was through the esophageal hiatus. The stomach was rotated on itself above the diaphragm and the hernia had been partially reduced by decompression as a result of drainage.

Surgery ten days after the onset of symptoms revealed enlargement of the esophageal hiatus and a sac, 8 cm. in diameter, protruding into the left chest, containing omentum, as well as a part of the stomach. The stomach and omentum were returned to the abdomen and the defect in the diaphragm was closed.

Four roentgenograms are shown, demonstrating the herniated stomach with torsion and incarceration at the antral level as well as the normal appearing stomach following operation. BERTRAM LEVIN, M.D.
Chicago, Ill.

Strangulated Right Diaphragmatic Hernia with Surgical Cure. Samuel D. Kushlan. Gastroenterology **18**: 466–477, July 1951.

The author reviews the literature and discusses the physical and roentgenologic diagnosis and treatment of strangulated diaphragmatic herniae. He reports one case.

From the literature it appears that, although a strangulated diaphragmatic hernia may be of the congenital type, it is predominantly traumatic. The history is usually that of acute abdominal pain, frequently with some premonitory abdominal or thoracic symptoms. The acute attack itself may occur months or years after injury. Roentgen examination not only establishes the diagnosis but is valuable in determining the location of the diaphragmatic rupture, its size, and the organs involved.

The reported case is that of a 70-year-old housewife admitted to the hospital because of generalized abdominal pain and vomiting of three days duration. Since being kicked in the abdomen nine months before, she had experienced episodes of post-prandial vomiting, of increasing frequency. Examination revealed flatness and absence of breath sounds at the left lung base, epigastric tenderness, and what appeared to be a large mass in the epigastrium. The abdomen was quiet. Roentgenologic examination revealed a normal esophagus deviated anteriorly in its lower half and surrounding the anterior portion of a large retrocardiac mass. The cardia of the stomach was dilated (the epigastric mass previously noted). The distal half of the stomach could not be filled, but the pars media, just proximal, appeared to swing upward and no stomach shadow could be visualized to the right of the spine. At the end of five hours there was complete gastric retention of the barium meal.

At surgery the distal third of the stomach and the proximal portion of the duodenum were found to be herniated through a 6-cm. defect in the right leaf of the diaphragm. The viscera were reduced and the defect closed. A film taken on the third postoperative day

showed a vertical area of decreased density with a dome-shaped superior surface in the right lower lung field; this contained an air-fluid level and seemed to lie directly posterior to the heart. In the belief that the patient might have a recurrent hernia, she was re-explored. There was no evidence of hernia, however, and the diaphragmatic defect was intact. It was thought that the x-ray findings represented the area which the previously herniated stomach and duodenum had occupied.

The author emphasizes the need for a postoperative roentgenogram of the chest immediately following operation, before the patient leaves the operating room. Had such a film been taken in this case it would have served as a base line for subsequent films and avoided the erroneous interpretation of recurrent hernia. A metallic marker in the region of the repair should aid in avoiding misinterpretation.

Six roentgenograms, demonstrating the preoperative and postoperative findings. BERTRAM LEVIN, M.D.
Chicago, Ill.

THE MUSCULOSKELETAL SYSTEM

Parosteal Osteoma of Bone: A New Entity. Charles F. Geschickter and Murray M. Copeland. Ann. Surg. **133:** 790–806, June 1951.

The authors describe 16 cases of a new bone tumor which is histologically related to myositis ossificans but has a more intimate relation to bone and is of graver prognosis. "Parosteal osteoma of bone" is the name given this new neoplasm. Initially, it is usually a benign proliferation of ossifying fibrous tissue, resulting in a rounded bony mass projecting from the shaft of a long bone near the metaphysis. It has no pedicle and no overlying cartilaginous cap, as does the more common osteochondroma. It eventually invades adjacent cortical and cancellous structures and extends peripherally into the soft tissues. Islands of cartilage may be found in the ossifying mass between bone-forming fibrous tissue. This benign phase resembles osteoma of the cranial membranous bones, but instead of remaining stationary it shows a tendency to progressive growth and ultimate malignant change akin histologically to sclerosing osteogenic sarcoma. This evolution extends over many years and the cure rate following amputation is high. The origin of new bone appears to be from bands of skeletal blastema, displaced from the primitive periosteum.

Clinical Features: Parosteal osteomas are found in early adult to middle life. The popliteal space is the most common site of occurrence. A hard, palpable mass, pain, and tenderness are the outstanding clinical features, being present for months or years.

Roentgenographically the lesion appears as a dense ossifying growth involving the ends of a long bone, but most prominently extending into the soft tissues with well delineated margins and occasional independent secondary osseous growths. Later in the process the ossifying mass seems to encase underlying bone.

Pathology: Grossly, the tumor is a well encapsulated bony mass attached to underlying bone. On cut section, radiating bony spicules are seen to traverse dense fibrous tissue. Microscopically, well differentiated osseous spicules, embedded in vascular stroma, are abundant and are surrounded by a single layer of osteoblasts. The periphery of the tumor may show increased cellularity or features of fibrosarcoma.

Prognosis: Pulmonary metastases occurred in 4 of the authors' 16 cases, in 2 more than five years after the primary excision. Four patients were alive and well five to fifteen years. In the remaining cases the average survival was three and a half years.

Treatment: Best results were obtained by early amputation, which the authors believe is the treatment of choice.

Differential Diagnosis: (1) Myositis ossificans gives a history of trauma in 60 per cent of the cases, reaches a maximum size in six to twelve weeks and thereafter is stationary. Radiographically it can be separated from underlying bone. (2) Intraligamentous osteomas (sesamoidomas) are benign encapsulated osteomas embedded in tendon sheaths or ligaments, are small, and do not show progressive growth. (3) Sclerosing osteogenic sarcoma begins within bone and has a rapid clinical course; histologically it is composed of irregular osteoid spicules without definite arrangement.

Conclusions: The authors believe that this new tumor has a primary origin in extraosseous connective tissue and is possibly derived from remnants of the primitive limb bud.

Twenty-seven roentgenograms; 17 pathological illustrations; 1 table. BRIT B. GAY, JR., M.D.
VA Hospital, Chamblee, Ga.

Osteogenic Sarcoma Arising in Traumatic Hemothorax and Hematoma of the Thoracic Wall. A Case Report. H. K. Stauss. Surgery **29:** 917–928, June 1951.

A 14-year-old Negro girl was struck a forceful blow on the back with a stick of wood in September 1949. From that time on a belt-like area of dull and sharp pain was present in the back, with radiation anterolaterally. In a few months the pain became more severe and constant and there were associated weakness, nausea, vomiting, cough, and right hemithorax discomfort with dyspnea. Some weeks later the patient was hospitalized and thoracenteses yielded large amounts of bloody non-purulent fluid.

Roentgenographic studies in February 1950 showed right hemothorax and a multitude of calcified areas distributed over the entire right inner chest wall. Between the eighth dorsal and first lumbar vertebra was a massive, irregularly calcified area with its main mass along the eleventh right rib at the scapular line. The ninth dorsal vertebra showed a compression fracture. A few calcific densities were present in the left chest. Films of the other bony structures showed no evidence of disease.

In mid-February 1950 decortication of the right lung and diaphragm was done. A shell of calcified material lay over the lung, extending into the fissures and hilus. Postoperatively there were many pulmonary and cardiac complications and right hemothorax recurred, followed by an empyema. Death occurred on the seventy-eighth hospital day.

The material removed at surgery appeared to be chondrogenic osteosarcoma; no pre-existing bone was found in numerous sections examined microscopically.

At autopsy the right leaf of the diaphragm was found to be replaced by osteoid tissue. Bony growth extended downward from the obliterated right costophrenic angle over the peritoneal reflections in the right upper quadrant, involving the periadrenal tissues, enveloping the kidney, cecum, and parts of the hepatic serosa, and distending the mesoappendix. The verte-

bral column was encased in tumor and a number of vertebral bodies were replaced by tumor tissue. Two-thirds of the right lung was destroyed. The great vessels, trachea, and esophagus were mere tunnels in the osteoid mass replacing the left laterally displaced mediastinum. No lymph node metastases were encountered.

Microscopic examination showed the cellularity and atypical structure of malignant osteoid tumor.

Twelve roentgenograms. BERTRAM LEVIN, M.D.
Chicago, Ill.

Lymphogranulomatosis of Bone. A. Vogt. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 697–706, June 1951. (In German)

Bone manifestations of lymphogranulomatosis may be osteolytic or osteosclerotic. The osteoplastic form is less frequent. In the vertebral bodies the osteoplastic process may be so marked that it simulates "marble" bone, and the bone overgrowth may be sufficient to cause pressure on the cord. After the spine, the sites of bone involvement in lymphogranulomatosis are, in order of frequency, the sternum, pelvis, femur, ribs, humerus, scapula, and clavicle.

An acute form is seen, following a rapid and fatal course. A primary chronic form also occurs, offering a better prognosis. X-ray examination may show an apparently diffuse infiltration, indicating an acute phase of the process, frequently changing gradually to a chronic stage. Sharply defined sclerotic changes and bone nuclei and well defined osteolytic processes indicate chronicity.

In the differential diagnosis one must consider metastatic carcinoma, Ewing's sarcoma (especially in youthful patients), reticulum-cell sarcoma, retothelial sarcoma, giant-cell tumor, and Paget's disease.

The author classifies the x-ray manifestations into five different types: (1) rapidly progressing diffuse osteolytic type; (2) sharply demarcated cyst-like areas alternating with extensive osteosclerosis; (3) periosteal type with marked periosteal elevation and increase in the diameter of the bones; (4) diffuse evenly distributed sclerotic changes within the bone (opaque glass-like osteosclerosis); (5) dense sclerotic involvement of the bony trabeculae without sharp demarcation.

Fourteen roentgenograms.

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Osteonephropathy in Children. J. James Cancelmo and Ralph S. Bromer. Am. J. Roentgenol. **65**: 889–915, June 1951.

Osteonephropathy designates several closely related conditions in which there are bone changes associated with renal disease. At least four clinical syndromes are recognized: (1) renal rickets, (2) Fanconi's syndrome, (3) nephrocalcinosis, and (4) idiopathic hypercalcuria. The present paper discusses 2 of these syndromes, renal rickets and nephrocalcinosis.

Renal Rickets: Between 1941 and 1949, inclusive, there were 25,275 admissions to the Children's Hospital (Philadelphia). Of these, approximately 1,508 were for medical and surgical genito-urinary diseases of all types. Eight cases of renal rickets were diagnosed (less than 0.6 per cent of the genito-urinary group).

The majority of present-day investigators believe that renal rickets is the result primarily of renal insufficiency, with all other phenomena coming into play secondarily. Kidney lesions of almost all types except tumor have been implicated as the cause. Generally these are divided into 3 groups: (1) infection or inflammation; (2) congenital anomalies; (3) obstructive lesions, as stricture of the urethra, bladder neck, ureter, etc. Most of the reported cases are apparently due to small atrophic kidneys, the result of long-standing chronic glomerulonephritis or pyelonephritis.

The pathological sequence of events is believed to be as follows: Because of the severe renal damage, the kidneys cannot excrete phosphates. This results in retention of inorganic phosphorus. There is then a depression of the serum calcium level as an adjustment to the high serum phosphorus level, resulting in parathyroid hyperplasia. Calcium is then drawn out of the bones in an effort to raise the level of calcium in the serum.

The kidney lesions in renal rickets are variable, but the end-results are the same, namely, marked glomerular and tubular insufficiency. In adults the bone changes are indistinguishable from osteitis fibrosa generalisata associated with primary hyperparathyroidism. Albright adopted the term "renal osteitis fibrosa generalisata" to describe the condition. In children there are epiphyseal lesions in addition to those of osteitis fibrosa. The lesions are not the same as true rickets histopathologically, but even in renal rickets, delay in the calcification of newly formed osteoid has been demonstrated. The hyperplasia of the parathyroids usually involves all four glands, but the glands are decidedly smaller than in primary hyperplasia.

Patients with renal rickets are often first seen because of a failure to grow and gain weight. Excessive thirst and polyuria may or may not be a symptom. Other than this, there are usually no symptoms referable to the urinary tract. Occasionally medical advice is sought because the child has stopped walking or because of gross bone deformities.

Dwarfism is common. The patients show a urine of low fixed specific gravity, elevation of the non-protein nitrogen and blood urea nitrogen, a normal or slightly depressed serum calcium with a high serum phosphorus, and an elevated alkaline phosphate. The CO_2-combining power is usually depressed, indicating acidosis. Anemia is moderate to marked.

The prognosis depends on the underlying causative urological condition. In most instances, this is of such an advanced nature that no cure is to be expected. Patients may live for years after the development of skeletal deformities, but almost invariably they eventually die of uremia or intercurrent infection.

Eight cases of renal rickets are described. The youngest patient was nine months, and the oldest thirteen years of age. Bone changes were atypical and pleomorphic. They resembled a combination of rickets and hyperparathyroidism, one or the other usually predominating. All of these cases showed a generalized demineralization, usually of a coarse trabecular type.

Radiologically, the cases are roughly divided into the rachitic type (Type A) and the wooly variety (Type B). Type A, the rachitic type, is practically identical with ordinary infantile rickets, and there are no characteristics to indicate or suggest renal rickets. In Type B, the more common type, the changes are not as symmetrical as in ordinary rickets. The metaphyses present a stippled, wooly, moth-eaten appearance with

irregular ossification, and although they appear longer than the metaphyses seen in ordinary rickets, they are not so splayed out. The stippled wooly appearance may also involve the skull, the tables of which are indistinguishable and considerably thickened. Subperiosteal erosion in the metaphyseal regions may be present, and this may be one of the most important features in the roentgenographic diagnosis of renal rickets. Subperiosteal or cortical erosions were present in 7 out of the 8 cases reported, and the authors believe that this phenomenon should be emphasized. They also occurred in conjunction with the rachitic type. Only 2 of the 8 cases presented the wooly type of change, although the subperiosteal eaten-away appearance was found in almost all of the cases.

Retarded skeletal maturation almost always occurs. In 1 of the cases there was a bone age of one and a half years in a patient whose chronological age was four. This does not occur in ordinary infantile rickets. Delay in osseous development is not, however, pathognomonic of renal rickets, as it occurs also in hypofunction of the pituitary and thyroid, in long-standing severe constitutional disease, and in the other osteonephropathies.

There were cyst formations in the metacarpals in 2 cases, and in the tibia in 1 case. In 2 other cases bilateral symmetrical insufficiency fractures were present. Punched-out areas involving the ulnar aspect of the distal radial diaphysis were seen in 2 cases. A peculiar notching in the head of the radius was noted in 2 cases. The amount of osteoid in the metaphyseal regions appeared to be less than that seen in ordinary rickets.

The urological findings depend on the nature of the lesion. Metastatic calcification may be present in the vessels, kidneys, subcutaneous tissue, and skin.

Nephrocalcinosis: In nephrocalcinosis there is a normal or slightly lowered serum calcium level and a low serum phosphorus level. In this event calcium cannot be deposited in osteoid, and a hypophosphatemic type of rickets results, similar to infantile rickets. For this reason the syndrome has been referred to as "Albright's true rickets." Clinically the children are dwarfed or stunted in growth. They may complain of polyuria or bone deformities. In this sense the condition resembles the picture seen clinically in renal rickets. However, the laboratory findings are entirely different. First, there is no elevation of non-protein nitrogen or blood urea nitrogen. If there is an anemia, it is usually mild. The blood phosphorus is low, and the serum calcium is normal or slightly depressed.

One case of nephrocalcinosis is presented.

Thirty-four roentgenograms; 1 photograph; 1 photomicrograph; 3 tables. MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Bone Dystrophy Associated with Muscular Dystrophy (Myopathy). D. W. Ashby, G. E. O. Williams, and O. E. Smith. Brit. M. J. **1**: 1486–1488, June 30, 1951.

Although osseous changes in neuromuscular disorders such as poliomyelitis and syringomyelia are well known, the bone changes sometimes found in muscular dystrophy remain obscure. Those mentioned in the literature include not only kyphoscoliosis and deformities of the skull, foot, and pelvis, but also atrophy of the clavicles, scapulae, ribs and innominate bones, and atrophy, narrowing, and sometimes shortening of the long bones. Hips are involved, and recently 5 cases of muscular dystrophy with coxa valga have been reported. The characteristic change in the long bones consists in reduction of the width of the shaft at the expense of the marrow cavity rather than of the cortex, whereas the epiphyses remain normal in width, giving the affected bone an attenuated dumb-bell shape.

Most authors discount muscular inactivity as a cause of the bone changes. In fact, in one case shortening of the vertical ramus of the mandible was found, though the masticatory muscles were not involved in the dystrophy. The only etiologic factor common to both the muscular dystrophy and the bone dystrophy is the familial incidence.

The authors report the case of a 28-year-old woman whose disease had its onset at the age of thirteen, with weakness of the upper arms and shoulders. At twenty-one she had a stillborn child, and after the puerperium her left leg became weak. At the time of examination she had a bilateral Sprengel's deformity of the shoulders with "wing scapulae," a myopathic gait, and could rise from the floor only by going through "Gowers' pathognomonic figures." Roentgenograms showed elevation and hypoplasia of the right scapula. The right humerus was shorter than the left and shorter than normal; its shaft was narrow, with reduction of the width of the medullary canal but not the thickness of the cortex. The ends of the bone were nearly normal in size, producing the "attenuated dumb-bell" shape. There was no evident decalcification. The rest of the skeleton showed no abnormalities.

Two roentgenograms; 1 photograph.

SIDNEY KING, M.D.
Chicago, Ill.

Skeletal Changes Resembling Scurvy in Infantile Hypothyreosis Before and After Thyroid Therapy. Arne Engeset, Olga Imerslund, and Wilhelm Blystad. Acta radiol. **36**: 1–11, July 1951.

The authors report 3 cases of cretinism and discuss the pre-treatment and post-treatment roentgenographic findings. The diagnosis was made on characteristic clinical signs, reduced longitudinal growth, mental deficiency, roentgen demonstration of delayed development of ossification centers, and the effect of thyroid therapy. The patients were from four to eight months of age at the time of initial diagnosis and study.

Each child showed a number of sutural bones, especially in the lambdoid region. There was considerable delay in the development of ossification centers. A moderate degree of generalized osteoporosis was present. In one case, the cuboid was absent at the time of the original roentgenogram, and in the other two cases, it was fragmented. A dense preparatory zone of calcification, linear in the metaphyses and annular about the round ossification centers, was noted in all cases. Below these lines was a zone of rarefaction.

"During thyroid therapy longitudinal growth and development of ossification centres occurred, while the previously mentioned two zones, the dense lines and the rarefied, persisted as transverse lines (in the metaphyses) or annular (in the round centres). New bone was formed epiphyseally to the transverse lines of the long bones, and in the round ossification centres new bone was noted outside the dense annular rings, as a characteristic ring of probably normal bone. A persistent central osteoporosis in the round centres is seen in contrast to the dense peripheral bone ring."

The first effects of thyroid therapy were noted to be increased longitudinal growth with the preparatory

zones of calcification persisting as transverse lines in the long bones, a central persisting osteoporosis surrounded by annular density in the round epiphyseal centers, and peripheral rings of new bone formation of varying thickness proportional to the time period of therapy.

Since the above-noted findings are also seen in scurvy, the possibility of concomitant scurvy was considered and ruled out by clinical and laboratory data. The roentgenological similarity between scurvy and hypothyreosis under treatment is apparently easily explained. "We have active therapy for both these diseases and by its exhibition the condition of the patient is immediately changed from a pathological to a more normal metabolism, making the contrast between the diseased and normal osseous tissue marked and easily distinguishable. The roentgenological examination hardly demonstrates characteristic changes *per se*, either in scurvy or hypothyreosis, but pathological osseous tissue in contrast to normal newly formed bone appears as a result of adequate therapy. The fact that the pathological osseous tissue (for example central osteoporosis in the round centres) persists long after the actual bone growth has become normal indicates that the normalization of old bone occurs more slowly than the growth of new bone in these regions."

Thirteen roentgenograms.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Hypertrophic Osteoarthropathy in Carcinoma of the Lung. John D. Pattison, Jr., Erwin Beck, and William B. Miller. J. A. M. A. **146:** 783–787, June 30, 1951.

As defined by Marie in 1890, hypertrophic pulmonary osteoarthropathy is a "symmetrical osteitis of the four limbs, chiefly localized to the phalanges and terminal epiphyses of the long bones of the forearm and leg, sometimes extending to the roots of the limb and flat bones, and accompanied by a dorsal kyphosis and some affection of the joints." It is to be differentiated from simple clubbing of fingers and toes, which is a proliferative change of soft tissues.

While hypertrophic osteoarthropathy is frequently found in association with chronic suppurative lung disease, it is important to realize that it often occurs in carcinoma of the lung, in which it may offer an early diagnostic lead, prior to pulmonary symptoms.

The affected bones show irregular, porous, rough accumulations of newly formed periosteal bone, usually thickest in the region of the peripheral epiphysis and at the points of musculotendinous insertions. The marrow of both new-formed periosteal bone and the old bone is richer and more vascular in the areas of active periosteal proliferation and fattier in the inactive areas. The most severe changes may disappear completely if the primary condition is cured.

Six cases of bronchogenic carcinoma with associated hypertrophic osteoarthropathy are reported here, in 5 of which the peripheral manifestations in the bone were the first significant evidence of the neoplastic lesion.

A brief review of the pathogenesis of the bone changes is included.

Seven roentgenograms.

JOHN F. RIESSER, M.D
The Henry Ford Hospital

Osteomyelitis Due to Friedländer's Bacillus. D. A. Muskat and M. Findlay. Lancet **1:** 1154–1156, May 26, 1951.

A fatal case of osteomyelitis due to Friedländer's bacillus is reported. The course was characterized by a high intermittent pyrexia, severe toxemia, moderately high persistent leukocytosis, and osteomyelitis of almost all the long bones, either simultaneously or in rapid succession. Even with definite radiological changes, pain, tenderness, and swelling (before the onset of gross suppuration) were slight. Although throughout the course of the illness there was no cough, expectoration, or clinical evidence of a lung lesion, the initial chest roentgenogram did show a patchy area of pneumonitis in the right upper lobe. The roentgen findings in the bones were so characteristic that one of the authors suggested the diagnosis before the report on a culture of pus aspirated from the abscess was obtained.

Five roentgenograms; 2 photographs.

Hypervitaminosis A, with Infantile Cortical Hyperostosis Irving E. Rineberg and Robert J. Gross. J. A. M. A. **146:** 1222–1225, July 28, 1951.

A case is reported in which the typical signs and symptoms of infantile cortical hyperostosis developed in a 33-month-old girl, with a history of excessive vitamin A intake for nine months. This patient is much older than any other described in the literature. The authors believe that the history of their case suggests that hypervitaminosis, although often minimized as a cause, may be the underlying factor in infantile cortical hyperostosis.

Six roentgenograms; 1 photomicrograph.

Fibrous Dysplasia of the Skull. William W. Feiring, Emanuel H. Feiring, and Leo M. Davidoff. J. Neurosurg. **8:** 377–397, July 1951.

Fibrous dysplasia is a condition affecting one, several, or many bones, the graver cases of which may present abnormal pigmentation of the skin, premature sexual development, hyperthyroidism, or still other extraskeletal abnormalities" (Lichtenstein and Jaffe). The term "Albright's syndrome" has been applied to those cases in which disseminated bone lesions are associated with cutaneous pigmentation and sexual precocity in females.

The skeletal lesions may be confined to a single bone or may involve a number of bones. Regardless of the clinical form assumed by the disease, the basic histopathological change is fundamentally identical in all cases. This consists of an accumulation of fibrous connective tissue which may be cellular or densely collagenous. Dispersed throughout the connective tissue, trabeculae of immature bone may be frequently observed. Islands of cartilage may also be observed within the fibrous tissue and occasionally cysts, areas of hemorrhage, giant cells or foam cells are to be found. With termination of the active phase of the disease, the fibrodysplastic tissue may become increasingly ossified.

Fibrous dysplasia is primarily a disease of childhood, its progress frequently becoming retarded or arrested when adult life is reached and skeletal growth ceases. Females are more commonly affected than males. The usual clinical manifestations are limp, deformity, pain, and pathologic fracture. In cases with advanced skull lesions, the degree of disfigurement may be considerable. When more than one bone is affected, the involvement is often exclusively or predominantly unilateral.

Long bones are mainly affected, the proximal parts more than the distal. Cutaneous pigmentation is fre-

quently found associated with the skeletal lesions. Sexual precocity occurs in a small proportion of cases, and in these the osseous lesions as a rule are marked and widespread. When fibrous dysplasia affects a tubular bone, the changes observed on roentgenographic study involve the shaft and metaphyses, rarely the epiphyses. The lesion appears as an area of decreased density which frequently causes expansion of the cortex of the bone. There may be ridges on the inner surfaces of the cortex, giving the impression of a multilocular lesion. The presence of bony trabeculae in many of the cystic areas gives rise to increased densities resembling ground glass.

About half of the cases with moderate skeletal involvement show skull changes. In those with marked skeletal manifestations, the skull is invariably affected. Involvement of the skull, on the other hand, occurs fairly frequently in the absence of demonstrable dysplastic lesions elsewhere in the body. It has been suggested by a number of observers that many of the cases classified as leontiasis ossea are in reality manifestations of fibrous dysplasia. The lesion designated as an ossifying fibroma also appears to be closely related to fibrous dysplasia.

The roentgenologic changes observed in the skull in cases of fibrous dysplasia are not uniform. The cyst-like, translucent areas typically found elsewhere in the skeleton are less often encountered here. They are usually restricted to the calvarium and are associated with widening of the diploe and thinning of the tables. More commonly the skull is the site of new bone formation, which causes an increase in the thickness and density of the affected structures. The localization of the skull and facial lesions may be unilateral and restricted to the side of the skeletal lesions when the latter involve only one side of the body. The calvarium, roofs of the orbits, the wings of the sphenoid bones, the anterior and posterior clinoids, the malar bone, paranasal sinuses, and mandible may all be affected.

The authors present 5 cases of fibrous dysplasia of the skull, 2 of which were definitely of the monostotic variety and 3 presumably so. Operation was performed in 4 cases, in 3 of which the preoperative diagnosis was meningioma; 1 was diagnosed as osteoma. In the remaining patient, the diagnosis was established on clinical grounds and subsequently verified histologically.

Confusion may arise in distinguishing between localized fibrous dysplasia and bony changes associated with a meningioma. One of the most valuable differential criteria is the age of the patient. Fibrous dysplasia is a disorder of childhood and adolescence. Meningiomas as a rule occur during adult life.

Six roentgenograms; 7 photomicrographs.

HOWARD L. STEINBACH, M.D.
University of California

Non-Osteogenic Fibroma of the Jaw. C. Agazzi and L. Belloni. Ann. Otol., Rhin. & Laryng. **60:** 365–369, June 1951.

Non-osteogenic fibroma is chiefly observed in older children and adolescents, having a predilection for the shafts of long bones. The authors record a case involving the jaw.

A woman of 22 gave a history of difficult and incomplete extraction of the first inferior right molar five years earlier. A year later a small hard painless mass appeared in the jaw in the neighborhood of the extracted tooth. This mass had increased in size until it measured some 5 cm. in diameter. It was adherent to the jaw-bone and its borders were not well defined. The overlying mucous membrane appeared normal.

Roentgenographic examination showed a conspicuous alteration of the bone structure with numerous irregular areas of rarefaction separated by thin, loosely interspersed septa which, at their crossing points, formed outlined density zones. The lower border of the jaw, thinner and interrupted in one place, was irregularly bulging. The lesion described comprised the area from the canine to the ramus of the jaw.

Under general endotracheal anesthesia, the right inferior third, fourth, seventh, and eighth teeth were extracted and the new growth was removed in small fragments. It consisted of several cavities, filled with an amorphous white lardaceous tissue. Microscopic examination showed a typical fibroma completely lacking in osteogenic activity. Here and there were traced small bits of lamellar bone tissue, *i.e.*, the septa responsible for the multicameral aspect in the roentgenogram.

The course of the disease is in accordance with the description of Jaffe and Lichtenstein (Am. J. Path. **18:** 205, 1942. Abst. in Radiology **40:** 427, 1943).

One roentgenogram; 1 photograph; 2 photomicrographs.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

X-Ray Examination of the Spine. Alfred O. Miller, J. Kentucky M. A. **49:** 254–261, June 1951.

The author discusses the radiographic technic needed in the examination of the spine. Anteroposterior and lateral views are not sufficient, but should be supplemented by oblique projections and special views of certain areas.

A systematic method of study of the films is outlined. First, the posture and alignment of the spine should be observed. The next step consists in evaluating the bone density and texture. A common abnormal finding is a senile demineralization. In younger individuals showing a generalized demineralization the possibility of a parathyroid adenoma should be considered. Localized areas of decreased density are usually due to tumors or infection. A generalized increase in bone density, such as is seen in Albers-Schönberg's disease or fluorine poisoning, is quite rare. A localized area of increased density is usually due to osteoblastic metastasis or lymphoma, but may represent infection or bone reaction due to long-standing stress.

The normal configuration of the vertebral bodies is considered next. It is important not to mistake the secondary centers of ossification at the anterior superior margins of the vertebrae for chip fractures. Wedging deformities occur as a result of trauma, juvenile osteochondritis, or as a manifestation of bone destruction from tumor or infection. The author makes the point that the lipping of the vertebral bodies in the older age group is a common occurrence and should not *per se* be called "arthritis." The interspaces normally are approximately the same width as their neighbors above and below. Narrowing at the fifth lumbar interspace is difficult to evaluate. It may be without significance if anomalous vertebrae are present; if, however, bone reaction is observed at the margins of the interspace, narrowing may be quite significant.

The pedicles represent the lateral margins of the spinal canal, and the absence of a pedicle or widening of the interpedicular space may be the result of tumor or localized infection.

The apophyseal joints are frequently neglected in the examination of the spine. These joints may be responsible for much localized back pain. They show the changes of rheumatoid arthritis and osteo-arthritis and are frequently the site of secondary involvement due to stress following changes in the vertebral bodies or interspaces.

The intervertebral foramina should always be examined when one suspects referred or root pain. Bony spurs may encroach on the lumen and produce nerve root pressure, particularly in the cervical region.

Following a presentation of this routine method of examination the author discusses some of the common disorders of the spine. The most frequently encountered congenital anomalies are found in the lumbo-sacral region. Probably the most common significant anomaly is the defect through the interarticular portion of the lamina of the fifth lumbar vertebra, which may lead to spondylolisthesis. Aseptic necrosis or osteochondritis of the vertebral epiphyseal plates usually involves the dorsal spine. It may result in symmetrical wedge-shaped deformities of the vertebral bodies.

Compression fractures of the vertebral bodies should be readily seen if films of good quality are available. One should not be satisfied unless all of the bodies can be seen. Oblique projections may be necessary to visualize fractures of the upper thoracic area. Open-mouth views of the odontoid should be used in cervical injuries to complete the examination.

Intervertebral disk herniation may lead to a narrowing of the involved interspace. However, lack of positive radiographic findings should not outweigh the clinical impression of posterior herniation.

Arthritis of the spine is of two types—the rheumatoid or Marie-Strümpell type and the osteoarthritic or degenerative type. Rheumatoid spondylitis involves the sacroiliac joints first and then produces changes in the apophyseal joints which may lead to ankylosis. Calcification of the paraspinal ligaments is a late manifestation.

Tuberculosis is the common bone-destroying infection of the spine. A paraspinal soft-tissue mass and interspace narrowing may be the earliest radiographic findings. Neoplastic destruction of the vertebral body is usually not associated with interspace narrowing. Most of the bone-destroying lesions in adults are metastatic. Destruction in children by Ewing's tumor or neuroblastoma may be quite extensive and may be confused with tuberculosis. DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Roentgen Pattern of the Infantile Spine. R. Seyss. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 434–440, April 1951. (In German)

The author describes in minute detail the infantile spine from the day of birth until the age of about three years. Numerous lateral films of the spine were taken on newborn babies and during early development. It is shown by means of drawings what changes one should expect in the spinal column. Variations in the roentgen pattern are discussed and traced back to the infantile or fetal phase. Depending upon the type of pathological process, step-like or beak-shaped changes in the vertebral column are seen in chondrodystrophy, myxedema, dysostosis multiplex, or chondro-osteodystrophy.

Four roentgenograms; 1 photograph; drawings.
JULIAN O. SALIK, M.D.
Baltimore, Md.

Radiographic Findings in Protruded Cervical Discs. Robert D. Moreton and George Ehni. South. M. J. **44:** 582–587, July 1951.

This study correlates the roentgen and surgical findings in 18 patients operated on for the syndrome of root irritation from the herniation of a cervical disk. Fourteen patients showed varying degrees of disturbance of the normal cervical curve, disturbance in the width of an interspace, interspace osteoarthritis, cervical gibbus, or a combination of these. Curve disturbance alone was seen in only one instance. Frequently the findings were localized to a single interspace and the lesion affecting the nerve root was found at the same level. Among the cases with multiple interspace involvement, a single example of multiple disk herniation was found.

Myelography was performed on 16 patients. In all the pathological lesion was correctly indicated.

The abnormalities due to lateral disk protrusions seen in cervical myelograms are broadening of the root bundle shadow, medial displacement of the root and sleeve shadow complex, superior displacement of a root and sleeve shadow complex, exaggeration of the normal transverse radiolucency over a disk, and total obliteration of the root and sleeve shadow complex.

The authors state that all of their myelograms showed constant, reproducible, non-filling defects or displacements of the sleeve shadow. In about half the patients the myelographic abnormality was of the obvious type usually associated with intradural lesions. In the others small defects were present which might have been overlooked with small amounts of medium.

Seven roentgenograms; 1 diagram.
MASON WHITMORE, M.D.
Jefferson Medical College

Discography of Dissecting Transosseous Ruptures of Intervertebral Discs in the Lumbar Region. K. Lindblom. Acta radiol. **36:** 12–16, July 1951.

The author studied so-called "persisting epiphyses" of the vertebral bodies by disk puncture and injection of dye into the disk center in 3 anatomical specimens and in 5 living subjects. The dye spread through anterior disk ruptures into the "epiphyseal line" in each instance, demonstrating that this line is really a fissure, continuous with a rupture and dissecting anteriorly.

Though these "persisting epiphyses" are usually anterior, they may on occasion be situated posteriorly. In such cases there is posterior disk rupture which invades the adjacent vertebra and continues through its posterior margin into the spinal canal.

In one case the injection of dye into an anteriorly ruptured disk between L-1 and L-2 caused severe abdominal pain. A similar reaction on injection of anteriorly ruptured disks occurred in two other cases without "persisting epiphyses." The author feels that it is probable that anterior disk ruptures may be a cause of abdominal pain and, therefore, the finding of anterior "persisting epiphyses" may have clinical importance. The transosseous ruptures penetrating posteriorly no doubt are able to produce symptoms by pressure on the posterior longitudinal ligament and the adjacent nervous structures.

It is concluded that so-called "persisting epiphyses" of the vertebral bodies are to be considered the result of dissecting transosseous ruptures of intervertebral disks.

Nine roentgenograms; 3 photographs and photomicrographs.
BERTRAM LEVIN, M.D.
Chicago, Ill.

Tarsal Anomalies and Peroneal Spastic Flatfoot. Frederick S. Webster and William M. Roberts. J. A. M. A. **146:** 1099–1104, July 21, 1951.

In 1948, Harris and Beath (J. Bone & Joint Surg. **30-B:** 624, 1948. Abst. in Radiology **53:** 613, 1949) reported 17 cases of peroneal spastic flatfoot, of which 88 per cent were the result of tarsal anomalies. They described a hitherto unrecognized tarsal anomaly causing rigid flatfoot, namely, a union between the talus and the calcaneus in the region of the sustentaculum. Since the publication of this report, the present authors have been taking special roentgenographic projections in all cases of peroneal spastic flatfoot. These consist of a posterior oblique view of the heel, with a downward and forward projection angle of 45 degrees for demonstration of the sustentacular joint, and an oblique view of the midtarsal region to show the calcaneonavicular bar. These views are most important since the anomalies cannot generally be demonstrated with routine projections.

In a series of 21 cases of peroneal spastic flatfoot thus examined, anomalies were found in 14. Eight patients had calcaneonavicular bars, 4 bilateral and 4 unilateral; 4 had a talocalcaneal bridge, 3 bilateral and 1 unilateral. In 2 patients both anomalies were present, unilateral in each instance.

The calcaneonavicular bar consists of a union between the anterior process of the calcaneus and the navicular, either a complete bone ridge (synostosis), a dense fibrous tissue bond (syndesmosis), or a cartilaginous bond (synchondrosis). It has been suggested that this anomaly results from fusion of a rare accessory tarsal bone, the calcaneus secondarius, to the calcaneus and the navicular. Another anomaly, the talocalcaneal bridge, consists of a bridge of bone spanning the subtalar joint and uniting the calcaneus with the talus immediately behind the sustentaculum. It may be a complete solid bony bridge (synostosis talocalcanea), or it may be incomplete with a fibrous bond (syndesmosis) or cartilaginous bond (synchondrosis) between the calcaneus and talus. An accessory joint may even exist. This has been attributed by some anatomists to the fusion of an accessory tarsal bone, the sustentaculum tali, to the astragalus and os calcis. It occurs, when present, at the posterior end of the sustentaculum tali. The bridge may be united in part by cartilage and in part by bone.

The position of the talocalcaneal bridge posterior to the sustentaculum tali as described anatomically can be well shown radiographically. Sometimes the synchondrosis can be distinguished as a thin serrated line of decreased density between the bone masses. This serrated margin has also been described anatomically and may be apparent on lateral films of the foot. On the posterior oblique view the bone mass and line of synchondrosis are visualized inferior to the level of the normal sustentacular ledge and joint line, as they lie posterior. The abnormal bone mass is of greater magnitude than the normal sustentacular process, and at times the line of synchondrosis is directed inferiorly and medially. There may also be a varying degree of osseous union.

The lipping of the dorsolateral margin of the head of the talus may or may not be evident early, but it is more frequently observed in cases of talocalcaneal bridge than in cases of calcaneonavicular bar. Arthritic lipping is especially significant of tarsal anomaly when occurring in combination with a good longitudinal arch and a young foot. Similar changes may occur in severe flatfoot without anomalies. In unilateral cases of tarsal anomaly, a severe flatfoot on the opposite extremity may show a greater degree of arthritic change and deformity of the arch than the side with the congenital abnormality. The symptoms are greater, however, on the latter side. The relative rigidity of the foot probably accounts for the lesser degree of tarsal arthritis in such cases. The symptoms are not proportionate to the extent of the anomalous osseous union. Although tarsal arthritis in feet with these anomalies is not a prerequisite for complaint, no asymptomatic foot in the authors' series revealed evidence of degenerative arthritis.

Treatment is dependent upon the anomaly, the type of syndrome, the age of the patient, and the degree of secondary arthritic change. Early recognition of the etiology of the peroneal spastic flatfoot influences the treatment and prognosis.

Eleven roentgenograms; 2 photomicrographs; 2 photographs.

Sprain-fractures of the Anterior Lip of the Os Calcis. Charles H. Bradford and Ivar Larsen. New England J. Med. **244:** 970–972, June 28, 1951.

Fracture through the anterior lip of the os calcis is not unusual but has received little attention in the literature. The reproductions of the roentgenograms in this article on the subject are rather poor, so that it is difficult to see the exact line of fracture, but the authors' review and clinical assay of the situation, as well as their discussion of the radiological characteristics, bear careful scrutiny. It is pointed out that unless the foot is tilted into moderate varus and equinus, the head and neck of the talus will obscure the lateral view by overshadowing the zone of the fracture. This can be brought into sharp relief against an unshadowed background by fully opening the sinus tarsi with inversion and plantar flexion of the foot. The authors also point out that the fracture may not show at all in the lateral view, and that careful anteroposterior views of the foot, throwing the lateral border of the anterior process of the os calcis into silhouette, may be necessary for a complete study. A confusing point is the rare possibility of an anomalous bone in this area (calcaneus secundarius), which may give an appearance of a fracture.

The mechanism of injury is reviewed and three case reports are detailed.

The prime importance of early diagnosis is apparent when the long convalescence necessary following this fracture is considered.

Two roentgenograms. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

GYNECOLOGY AND OBSTETRICS

Joduron-S, a New Water-Soluble Viscous Contrast Medium for Hysterosalpingography. F. K. Fischer and Lorentz Meyer. Schweiz. med. Wchnschr. **81:** 573–581, June 16, 1951. (In German)

The authors believe that water-soluble contrast media are much to be preferred to oily preparations. The disadvantages of contrast media in oil are as follows:

1. The iodine is not in a stable combination. It is easily split off and may produce iodism.

2. Because of their high viscosity, the oils are not miscible with the secretions of the body. Therefore, in-

sufficient filling of the body cavities is obtained and sometimes faulty demonstrations may be produced. Narrow lumina can be filled only under great pressure, which may be dangerous and may produce embolism.

3. Oils may be retained after hysterosalpingography for weeks, months, or even years, resulting in chronic inflammatory processes. Encapsulated remnants of oil within the pelvis may produce chronic adhesive processes. Foreign body salpingitis with subsequent closure of the tubes has been observed.

The water-soluble contrast media have many advantages. They have a desirable radiodensity, are quickly and easily absorbed, are harmless, and have no qualities which might produce tissue irritation. At Zürich University, Joduron-B, a water-soluble contrast medium, has been used for some time for bronchography. For hysterosalpingography and cholangiography a preparation with a lower viscosity, known as Joduron-S, has been recently produced.

Joduron-S consists of two substances, an active contrast medium and a vehicle. The contrast medium is a 35 per cent diethanolamin salt of di-iodo-pyridon-N-acetic acid. The molecule of this compound contains the iodine in a stable combination so that it cannot be split off within the organism. The vehicle is a watery colloidal solution of cellulose (a sodium salt of carboxy-methyl-cellulose). Both substances are fairly water-soluble and mix easily with the watery secretions of the body. A preservative is added. The resorption of Joduron-S is very rapid, but good films can be obtained within about fifteen minutes after injection. Never has the medium been retained more than two hours.

Hysterosalpingography with Joduron-S is done under fluoroscopic control, spot films and regular Bucky films being taken as indicated. Due to the hypertonicity of the medium some anesthesia is required. The quantity of contrast medium used varies with the size of the uterus. If 3 c.c. or less is sufficient to fill the uterine cavity a diagnosis of infantile uterus is made. A normal uterine cavity takes about 5 c.c., but under pathological circumstances up to 100 c.c. may be necessary. For the visualization of the tubes the pressure has to be increased. Ordinarily for a hysterosalpingography between 15 and 20 c.c. of Joduron-S are needed. For the visualization of the pelvis, up to 100 c.c. are used. After the examination, the patient receives a prophylactic injection of 600,000 units of procaine penicillin.

The contraindications are about the same as with the use of oil, but ill effects are much less likely to occur. Even in the presence of tuberculosis, Joduron-S may be used.

Measurements within the rectum have shown that the average examination produces an x-ray dose of between 7 and 13 r. Kjellberg has concluded that this dosage of x-rays may produce a slight increase in the normal mutation frequency, but the information obtained by the method is so valuable that it outweighs many times this slight risk.

Twenty-two roentgenograms; 1 photograph.

WM. A. MARSHALL, M.D.
Chicago, Ill.

Significance of Pressure in Hysterosalpingography; A New Instrument for Measuring Pressure. C. Müller. Schweiz. med. Wchnschr. **81:** 639–641, July 7, 1951.

The dangers of hysterosalpingography are listed as follows: (1) infection, which may occur even if the procedure is done under strictly aseptic conditions; (2) mobilization of cells of a beginning neoplasm; (3) production of an ectopic pregnancy; (4) sterility through local irritation; (5) penetration of the contrast medium into venous or lymphatic channels; (6) perforation of the cervix (usually harmless); (7) injuries to the wall of the tubes due to over-distention.

The greatest number of complications has probably arisen from using too high a pressure in introducing the medium. Complications are unlikely to occur if the pressure is maintained at between 150 to 200 mm. mercury. Inquiries as to the use of manometers indicated that over 50 per cent of hysterosalpingograms are made without the use of a pressure-measuring device, the syringe being simply attached to the cannula. This is accounted for by the fact that measuring devices which can be sterilized are not easily available. With this in mind, the author has devised a measuring device which will permit an aseptic technic.

The apparatus consists of a small drum placed between the syringe and the cannula. This drum has an elastic steel membrane on one side which will bulge when the oil pressure within the drum is increased. On the other side of the drum is a spring-operated ball-type safety valve which can be set to a certain threshold. The drum can be sterilized. A sphygmomanometer which does not have to be sterilized is placed over the elastic membrane and as the latter bulges, it registers the pressure on the needle of the manometer. When the pressure exceeds a certain safe limit, the contrast medium will escape through the safety valve.

The author does not consider fluoroscopic control of hysterosalpingography safe. He believes that exposures of as little as 3 r may produce mutations in the germinal cells, and in prolonged fluoroscopic observation this amount would be exceeded many times.

One roentgenogram; 1 drawing.

WM. A. MARSHALL, M.D.
Chicago, Ill.

Pneumoperitoneum in the Study of Pelvic Structures. J. R. Maxfield, Jr. J. A. M. A. **146:** 920–923, July 7, 1951.

By supplying contrast which is not normally present, pneumoperitoneum can give information about practically any abdominal structure. At times it is the only means of obtaining the desired information short of surgery. In the hands of capable radiologists it is accompanied by no risk. The only contraindications are cardiac insufficiency and acute infection.

The use of pneumoperitoneum for the study of pelvic structures has long been advocated by Stein (see, for example, Radiology **28:** 391, 1937), and attention is again called to its usefulness in this field.

Two cases are reported. In one, pneumoperitoneum demonstrated an ovarian tumor which the surgeon was not able to palpate. In the other, a thickening in one side of the pelvis was definitely identified as recurrent cancer (because of the nodular contour) by this means.

Two thousand cubic centimeters or more of CO_2 are injected through a dull 18- or 20-gauge spinal needle 1 inch below and 1 inch to the left of the umbilicus. Lateral decubitus films are taken with the head down 15° and a postero-anterior film with the table inclined to 45° and the beam angled downward through the pelvic strait.

Five roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Salpingovaginal Fistulae: Report of Case. Gershon J. Thompson and Virgil S. Counseller. J. Urol. **65**: 853–855, May 1951.

Profuse drainage from the vagina which may follow hysterectomy is usually due to vesicovaginal or ureterovaginal fistula occurring as a result of accidental damage to the bladder or to the ureters. A case is here presented of salpingovaginal fistula following vaginal hysterectomy for fibroids. Dribbling of fluid from the vagina began three days postoperatively. Excretory and retrograde urography, as well as cystoscopic examination, revealed no connection between the urinary tract and the vagina. Injection of a small opening in the vagina from which the fluid was escaping revealed a fistulous tract adjacent to the ureter but not communicating with the urinary tract. Later a catheter was inserted 20 cm. into the fistulous tract, and opaque medium injected through this was shown roentgenographically to have drained into the cul-de-sac. Laparotomy showed the catheter entering the peritoneal cavity through the fimbriated end of the left fallopian tube. The tube was removed and the area reperitonealized.

Absence of ureterectasis, which is always present when ureteral injury has resulted in fistulous tract formation, was the differential point which led the authors to arrive at the proper diagnosis preoperatively.

Two roentgenograms; 1 photograph.

ROBERT P. BOUDREAU, M.D.
University of Pennsylvania

Transverse Diameter of the Inlet. D. Frank Kaltreider. Am. J. Obst. & Gynec. **62**: 163–166, July 1951.

The author analyzed a series of 1,167 consecutive pelvimetric studies done on suspect pelves with the Steele and Javert isometric technic of measurement. The purpose of the study was to evaluate the part played by the transverse diameter of the pelvic inlet in difficult delivery and to compare it with the part played by the obstetrical conjugate (A.P.) diameter. The criteria for difficult delivery were: (1) cesarean section performed after the biparietal diameter of the fetal head had failed to pass through the pelvic inlet following a well defined trial of labor; (2) intracranial injury in the child after vaginal delivery.

The author found that of 52 patients in whom the C.O. (obstetrical conjugate) was less than 10 cm. and the transverse diameter of the inlet was less than 12 cm., 30.8 per cent had difficult deliveries. When the C.O. was greater than 10 cm. and the transverse greater than 12 cm., only 0.34 per cent of 577 patients had difficulty. With a C.O. of less than 10 cm. and a transverse greater than 12 cm. (35 cases) the incidence of difficulty was 11.4 per cent, and with a C.O. greater than 10 cm. and a transverse less than 12 cm. (320 cases) the incidence was 10.95 per cent. No measurements of the other pelvic diameters are given in this study.

From these tabulations, the author concludes that the transverse diameter of the inlet is probably as important as the obstetrical conjugate in the determination of inlet dystocia. Ten and 12 cm. may be used, respectively, as the border-line measurements for the obstetrical conjugate and the transverse diameter of the inlet. If either of these diameters is above borderline and the other is below, difficulty may be expected in 1 of 9 patients; if both are below borderline 1 of 3 patients will have difficulty.

The author feels that his percentage computations may be applicable in the prognostication of difficulty of vaginal delivery in cases of disproportion at the inlet, though further and more exact information, both clinical and roentgenographic, must be available for more precise prediction in the individual case.

Three charts.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

THE GENITO-URINARY SYSTEM

The Physiology of Micturition. S. Richard Muellner. J. Urol. **65**: 805–810, May 1951.

The author has continued his fluoroscopic studies of micturition (see Muellner and Fleischner, J. Urol. **61**: 233, 1949. Abst. in Radiology **54**: 148, 1950) until more than 300 observations have been made. His observations confirm the importance of a properly functioning pelvic floor, abdominal wall, and thoracic diaphragm for physiologic micturition in man. Dysfunction of these muscles, and especially those of the pelvic floor, is shown to have a direct bearing on man's ability to start or to stop the urinary stream at will. The above observations fail to substantiate the belief expressed by some that man voids by wilfully contracting his detrusor, a theory not in accord with the physiology of involuntary (smooth) muscle. The view that voluntary micturition is brought about by the removal of the inhibitory effect of the brain (will) on the detrusor, which then proceeds to contract, also could not be confirmed. Both theories fail to account for the function of the voluntary mechanism.

Eleven roentgenograms.

Intestinal Gas During Pyelography. Myron J. Tremaine, Vincent J. O'Conor, and Walter G. Maddock. J. Urol. **65**: 1129–1136, June 1951.

The authors are interested in the general problem of gastro-intestinal gas and in the occurrence of meteorism during pyelography in particular. A portion of the literature is reviewed which tends to disprove the theories of food fermentation and of gaseous absorption from the blood stream in the intestinal tract as the source of the gas. Studies are also cited offering evidence that swallowed air reaches the cecum in about ten minutes and makes its appearance as flatus in about thirty minutes.

The authors consider the rapid accumulation of gas in the intestines during pyelography an excellent example of the aspiration and rapid transit of external air through the alimentary tract. To prove their contention, they carried out a study on patients undergoing retrograde or excretory pyelography. Liquids were restricted for several hours (before retrograde pyelography) and no breakfast was given. A gastric tube was kept in the stomach and the amount of gas aspirated from the stomach during the procedure was carefully tabulated. This gas was analyzed and found to be essentially identical with external air. The amount of gas in the intestinal tract was carefully followed by means of roentgenograms. The air seemed to enter the stomach, not by means of swallowing, but during deep respirations.

The following points were noted:

1. When the stomach was kept entirely free of air by means of continuous suction through the gastric

tube, there was no increase in intestinal gas from the initial to the final pyelogram.

2. If the gastric tube did not function well, there was an increase in gas in the intestinal tract during the pyelographic studies, the result of some air passing through the pylorus.

3. Approximately three times more air was aspirated from the stomachs of nervous patients than from the calm ones.

The conclusion from this study is that the rapid accumulation of intestinal gas during pyelography is due to external air passing into the gastro-intestinal tract *via* the esophagus and stomach. It is definitely related to nervous stimuli, the factors responsible being intravenous injections, the passage of the cystoscope and ureteral catheters, the introduction of fluid into the renal pelvis, and the general lower-abdominal discomfort These stimuli resulted in irregular deep respirations, during which period the intake of air was the greatest.

It is felt that the use of continuous gastric suction as a means of obtaining more adequate urographic studies is a bit too drastic, but that the use of sedatives to allay fear and apprehension might be of value.

Two roentgenograms; 2 graphs; 1 table.

NORMAN J. WINSTON, M.D.
University of Pennsylvania

Congenital Ureteral Dilatation with Renal Hyperparathyroidism. Robert Brendze and R. William Provenzana. J. Urol. **65**: 989–993, June 1951.

The case of a 14-year-old white boy suffering from hyperparathyroidism with associated skeletal lesions secondary to renal insufficiency is presented. The renal insufficiency resulted from congenital bilateral ureteral dilatation.

The patient's complaints were increasing polydipsia and polyuria, with persistent albuminuria of eight years duration. He had experienced frequent bouts of severe upper respiratory infection, but there had been no previous renal infection. The boy was poorly developed, weighing 69 pounds and appearing about ten years of age. The face was puffy, particularly in the peri-orbital regions. The blood pressure was 110/65. Except for a mass in the left upper quadrant of the abdomen, there were no other significant physical findings.

Urinalysis was negative. At no time during hospitalization were the kidneys able to concentrate urine of specific gravity in excess of 1.015, even on rigid fluid restriction. There was a moderately severe normocytic hypochromic anemia with a white cell count of 11,440 and a normal differential count. The sedimentation rate (Wintrobe) averaged 55 mm. The serum protein was 8.1 gm., the non-protein nitrogen varied from 243 mg. to 122 mg. per cent; the CO_2 combining power was 15 mg. per cent; serum chlorides 617 mg. per cent; serum calcium 11 mg. per cent; serum phosphorus 6.25 mg. per cent; alkaline phosphatase 10.8 Bodansky units; blood creatinine 8 mg. per cent; total blood cholesterol 461 mg. per cent.

In spite of the disturbed blood chemistry, the patient's only complaint was intermittent weakness. When the acidosis was corrected, the serum calcium fell to 6.4 mg. per cent.

Because intravenous urography failed to reveal any dye in the urinary tract, retrograde pyelography was performed. No evidence of urethral or ureteral obstruction was obtained, but both ureters were enormously dilated, tortuous, and kinked. No dye entered the kidneys, and the bladder appeared greatly dilated.

X-ray films of the long bones showed diffuse osteoporosity of the shafts, with irregularity of the epiphyses and widening of the epiphyseal lines. Skull films revealed many irregular, rounded cystic areas.

At the time of this report the patient was still being observed in the out-patient clinic. Symptoms persisted but had not increased in severity.

The etiology of congenital ureteral dilatation is obscure. The syndrome described here is the result of extreme renal insufficiency of long duration which acts as a stimulus to the parathyroid glands. These react by an increase in volume and excessive production of the parathyroid hormone, with resultant osteoclastic bone lesions. In contrast to primary hyperparathyroidism, where marked hypercalcemia results, hyperparathyroidism secondary to chronic renal disease cannot compete with the renal insufficiency and the blood calcium is normal or depressed. Because of the retained phosphorus—the result of kidney disease—insoluble calcium phosphate is excreted by the bowel, resulting in calcium starvation.

This syndrome has been observed with other renal lesions, as congenital urethral valves, cystic kidneys, chronic nephritis, and obstructive uropathy.

Four roentgenograms.

THOMAS R. HEPLER, M.D.
University of Pennsylvania

Circumcaval Ureter. John A. Dougherty. California Med. **75**: 48–50, July 1951.

Circumcaval ureter occurs as the result of the persistence of the posterior cardinal vein beyond fetal life. The inferior vena cava is ordinarily formed by the union of that part of the vena cava which lies cephalad to the kidney, and the iliac veins at their junction; the cardinal vein then atrophies. When it fails to atrophy, the cardinal vein becomes the main channel of the inferior vena cava, and the ureter must pass behind it. This condition gives rise to ureteral obstruction and varying degrees of renal damage.

The case of a 35-year-old woman is reported in whom retrograde pyelography demonstrated unilateral hydronephrosis. Because of the typical redundancy and curvature of the upper end of the ureter, a diagnosis of circumcaval ureter was made. Operation was performed and the diagnosis confirmed. Two centimeters of the redundant ureter were removed and anastomosis performed with the ureter above the vena cava. After two years the hydronephrosis had subsided, and the kidney apparently functioned well.

Four roentgenograms.

FRANK T. MORAN, M.D.
Lancaster, Penna.

THE BLOOD VESSELS

An Evaluation of Translumbar Arteriography. Parke G. Smith, Thomas W. Rush, and Arthur T. Evans. J. Urol. **65**: 911–921, May 1951.

It has long been known that any interference with the mechanical efficiency of either of the two exits from the renal parenchyma, ureter or vein, predisposes to an increased pressure within the renal capsule, producing renal pain. Intravenous urography and retrograde pyelography permit the study of the ureteral exit, and the authors hope that translumbar arteriography will permit study of the venous exit. They have employed

this procedure in over 300 cases. As a contrast medium they have used 75 per cent neo-iopax, 70 per cent diodrast, and are now studying 70 per cent urokon. The technic is fully described.

In the entire series the authors had no fatalities and the morbidity was "amazingly insignificant." The only complaints were occasional lower chest pain and, infrequently, left shoulder pain. On several occasions the superior mesenteric artery was accidentally injected without ill effect, due perhaps to the use of only 12 c.c. of contrast medium. Other writers have reported mesenteric thrombosis as a result of this accident.

The fear of hemorrhage following aortic puncture proved unwarranted. Some patients may bleed slightly, but not to a dangerous extent.

Hypertension and arteriosclerosis are not considered contraindications to the procedure.

Aortic intramural injection was encountered once, but autopsy twenty-four days later showed no abnormalities in the aortic wall. Extra-aortic injection of the contrast medium or extravasation occurred more than 25 times. Except for predisposition to pain in the lower left chest, these patients had no difficulties, and complete reabsorption of the dye took place.

Sensitivity to the contrast medium has not been seen by the authors. Sensitivity tests are performed, and it is imperative to ascertain that the patient is not in renal failure.

The perforation of an intraperitoneal hollow viscus with the needle or the creation of a pneumothorax was not recognized in this series.

The authors conclude that the technic is simple but absolute precision is necessary. They list the values of arteriography as follows: to demonstrate aberrant vessels in normal kidneys or anomalous vessels in abnormally located kidneys; to visualize a renal mass and its renal blood supply when excretory or retrograde urography is not successful due to ureteral obstruction and a non-functioning kidney; to correlate kidney function with blood supply; to demonstrate vascular space-occupying areas, indicative of cysts; to confirm a diagnosis of tumor by laking, puddling, and pooling of the medium; to differentiate aneurysm of the splenic artery, aorta, or other abdominal arteries from other intra-abdominal masses; to demonstrate renal artery or aortic obstruction; to differentiate extrarenal retroperitoneal tumors from renal tumors; to evaluate the renal blood supply of hypertensive patients in order to determine if the Goldblatt phenomenon is in effect.

The need for further correlation of arteriograms and pathological specimens is recognized. There is still much to be learned regarding roentgenographic interpretation. The utilization of multiple exposures will undoubtedly give more information.

Eleven roentgenograms; 3 photographs.

FRANCISCO CAMPOY, M.D.
University of Pennsylvania

A Phlebographic Study of Constrictive Processes in the Superior Vena Cava Area and of Accompanying Changes in the Collateral Circulation. Ernst F. Salén. Acta radiol. **36**: 81–87, July 1951.

When the clinical picture of superior vena cava obstruction is not characteristic, mediastinal phlebography (angiocardiography) is of importance in determining the degree of stenosis and estimating the course of the collateral circulation.

Simultaneous phlebography in two perpendicular planes was made in 27 cases of occlusion of the superior vena cava. In 9 cases collateral circulation was demonstrated—5 cases due to mediastinal metastases from inoperable lung tumors, 3 to postoperative thrombophlebitis, and 1 to lymphoma. Two different venous groups were found to supply the collateral circulation when the vena cava is blocked. One is a group of superficial veins made up of the internal mammary veins and their caudal and cranial communications and the lateral thoracic veins and communications. The internal mammary veins open cranially into the innominate veins, the lateral thoracic veins open into the axillary veins. Both of these pairs of veins communicate caudally with the superficial veins of the abdominal wall which empty into the inferior vena cava system. The second system of veins is a deep one, the azygos. The azygos vein originates in the posterior superior portion of the abdominal cavity, courses upward in the posterior mediastinum and opens into the posterior wall of the superior vena cava immediately before the latter vessel enters the pericardium. In the mediastinum the azygos vein receives the superior intercostal vein and in the abdomen it connects with the inferior vena cava via the upper lumbar veins. The stems of the venous networks noted above communicate with each other through the transverse intercostal veins.

Judging from the phlebograms, the azygos system is a very important collateral pathway. In man it apparently easily becomes adapted to a reversed circulation. In dogs this venous system does not possess the same adaptability. The cause for this is not evident; some difference in structure of the valves may play a part.

Three case histories are given and 6 roentgenograms are shown.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Percutaneous Retrograde Phlebography of the Leg. Tore Sylwan. Acta radiol. **36**: 66–80, July 1951.

The author points out that the function of the deep veins of the leg cannot be adequately assessed except by retrograde phlebography. Phlebograms taken proximal to the site of injection of an aqueous solution into a peripheral vein are frequently misinterpreted. There are several reasons for this; the most important is probably the rapid sedimentation of the injected contrast medium due to its relatively high specific gravity. The most that can be said, even when there is not filling of the deep veins, is that there may be something wrong with these vessels.

The important question of whether or not the deep veins are capable of receiving and transporting blood from an area from which veins have been removed can best be solved by retrograde phlebography. The author's report is based on 96 cases in which this procedure was done.

The patient lies in a supine position with his leg on a foot support which is lowered to an angle of 65 degrees with the horizontal plane. The femoral vein is punctured just below the inguinal ligament, the needle being directed toward the knee, and 40 c.c. of a 35 per cent umbradil solution are injected, the first 20 c.c. slowly over a period of one minute and the second 20 c.c. as rapidly as possible. Films of the thigh are taken in the sagittal plane after injection of the first 10 c.c. and after the first 20 c.c. Toward the end of the second 20 c.c. a third sagittal film of the thigh is taken and, immediately after the injection, films of the thigh, knee, and calf are obtained in sagittal and lateral planes. All exposures

are made with the tube tilted 10 to 12 degrees toward the feet; the focus-film distance is 1 meter, and the exposure period half a second to one second, at about 70 kv.

The reasons for this injection technic are as follows:

If the blood flow in the femoral vein is slowly ascending, the valves will be kept slightly open and the contrast solution can travel down between them when slowly injected. With the rapid injection the maximum rise in the injection pressure presses the valves together so that the bulk of the opaque medium travels upward.

The author postulates functional insufficiency of a deep vein in cases where, with forced injection, the density of the medium increases distally in the vein. The value of retrograde phlebography as evidence of the function of the deep veins is, nevertheless, doubtful. "As the physiology of the venous circulation in the legs is still not completely understood, results like those reported here cannot be absolutely reliable, in so far as they be taken as a measure of the capacity of the veins to transport the blood away from the legs."

A number of cases are discussed, with reproductions of films demonstrating pathologic anatomical changes in the deep veins of the thigh. A dilated profunda femoris vein with varicose branches is shown communicating widely with superficial varices in the calf. Changes were encountered in the profunda femoris at least as often as in the vena femoralis.

In 28 examinations there was retrograde filling of the deep femoral vein suggesting valvular insufficiency; the superficial femoral vein appeared insufficient in 27 examinations. In 15 examinations the opaque medium passed downward into the long saphenous or subcutaneous veins of the thigh and assessment of the function of the deep veins was not possible.

In 25 cases communication between the deep veins of the thigh and the superficial varices was demonstrated either directly or indirectly. Nearly all communications were in the region of the hiatus adductorius. This is also the site of predilection of deep varices involving branches of the profunda femoris vein and communications between this and the superficial femoral vein.

In cases where the retrograde flow of the medium is stopped by the proximal valves in the femoral veins, it cannot be known with certainty that pathologic changes have not occurred more distally. The author therefore tried retrograde phlebography by injecting the popliteal vein. The method was abandoned after a few attempts because of the difficulty in keeping the needle in the vein.

Retrograde femoral phlebography is indicated when there is reason to suspect pathologic changes in the deep veins and surgical treatment is contemplated. The examination is particularly important before operation on the superficial femoral and popliteal veins. If the superficial femoral vein is removed, the deep femoral must then carry most of the blood from the lower extremity.

The author lists the following as contraindications to the examination: severe renal and hepatic affections, heart disease with decompensation, and hypersensitivity to the contrast medium.

Twenty-four roentgenograms.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Arteriovenous Fistula Between the Middle Meningeal Artery and the Greater Petrosal Sinus. Edgar F. Fincher. Ann. Surg. **133:** 886–888, June 1951.

A case of traumatic arteriovenous fistula between the middle meningeal artery and greater petrosal sinus is presented. The patient was a woman of 24 years, who six years earlier had sustained a skull fracture. After three days of unconsciousness, she had remained asymptomatic for a period of thirty days, at the end of which time she noticed a "buzzing" in the left ear. This had continued over the six-year interval. On examination, a bruit with systolic accentuation was heard over the ear. Carotid angiography revealed a tortuous hypertrophied middle meningeal artery in an enlarged foramen spinosum, draining into the greater petrosal sinus. The lesion was resected in two operations.

No similar case was found in the medical literature, and in 814 cases of aneurysms and fistulas tabulated during World War II from vascular centers in this country, there was no mention of involvement of the middle meningeal artery.

Two roentgenograms.

BRIT B. GAY, JR., M.D.
VA Hospital, Chamblee, Ga.

Portography. Technic and Indications. L. Leger, L. Gally, N. Arvay, J. Oudot, and J. Auvert. J. de radiol. et d'électrol. **32:** 633–636, 1951. (In French)

Study of the trunk of the portal vein draws its interest from clinical manifestations of portal hypertension and from its surgical treatment by establishment of an anastomosis between the portal system and the caval system. Injections were first made into the portal system of several dogs before and after portal ligation and into cadavers of recently deceased patients. In living patients a polythene catheter is inserted into the right gastro-epiploic vein or one of the other portal tributaries (splenic, inferior or superior mesenteric) after the abdomen has been opened surgically. Twenty cubic centimeters of 50 to 70 per cent diodone are then injected, preferably in two to three seconds. One case cited showed a thrombus at the extremity of the portal trunk.

Six roentgenograms; 3 drawings.

CHARLES M. NICE, M.D.
University of Minnesota

TECHNIC, APPARATUS, CONTRAST MEDIA

Transverse Axial Laminagraphy with Partial Rotation of the Patient. Luigi Oliva. Radiol. med. (Milan) **37:** 433–445, June 1951. (In Italian)

The author has studied the possibility of obtaining transverse laminagraphs by rotating the patient less than 360 degrees. He states that such laminagraphs may be taken with rotation of 180 degrees or more, but that the best results are still obtained with complete rotation.

Nine figures.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Diagnostic and Therapeutic Nerve Blocks: Necessity for Roentgenograms. John W. Pender and David G. Pugh. J. A. M. A. **146:** 798–801, June 30, 1951.

For effective placement of needles in performing diagnostic and therapeutic nerve block, roentgenograms both in anteroposterior and lateral projections must be obtained. Without this visible evidence, per-

formance of these procedures is more difficult and reproduction of results less likely.

The authors describe the roentgenographic control of nerve blocking in several situations. They stress the value of objective records both in contemplating selective intervention and in predicting the efficacy of injection of small volumes of the anesthetic agent.

The proper use of roentgen localization enjoys here the same advantages that are recognized in any situation where the only other alternative would be reliance on crude, external physical impressions.

Seven roentgenograms. JOHN F. RIESSER, M.D.
The Henry Ford Hospital

A Nonopaque Roentgenographic and Water-Repellent Examining Table Mat. M. Swick. J. Urol. **65:** 924–926, May 1951.

Because the average x-ray table is uncomfortable to the debilitated or bony patient, the author has attempted to find a suitable mat which will not interfere with the efficiency of the roentgen examination. He uses a 1- to 2-inch mat, which is snugly pillow-cased in a specially devised removable, water-repellent rubber cover with a zipper at one end. This adds to the comfort of the patient without in any way impairing the quality of the films.

Four roentgenograms; 1 photograph.
RICHARD V. WILSON, M.D.
University of Pennsylvania

Late Effects of Thorium Dioxide in Man. Chester Cassel, Julian M. Ruffin, Robert J. Reeves, and Leland D. Stoddard. Arch. Int. Med. **88:** 42–50, July 1951.

In order to assess the late effects of thorium dioxide, three patients were studied, seventeen, sixteen, and thirteen years, respectively, after 75 c.c. had been administered intravenously. The persistence of thorium dioxide was shown by roentgen opacity of the liver and spleen, the demonstration of gamma radiation over these organs, and the presence of material morphologically compatible with thorium dioxide in liver tissue obtained by needle biopsy. No significant effect on hemopoiesis, hepatic function, or the general health of the patients was disclosed. Liver biopsy specimens showed clumps of phagocytes containing the granular material largely in portal fields, and 2 patients had changes characteristic of Laennec's cirrhosis. In the 2 cases in which definite fibrosis occurred, there was no direct evidence that the thorium dioxide was responsible, since thorium was seen both in juxtaposition to areas of fibrosis and also in contact with morphologically normal cells, and fibrosis was present both with and without adjacent thorium granules. None of the specimens showed inflammatory, degenerative, or neoplastic alteration in relation to the thorium dioxide.

The roentgen appearance of the liver and spleen soon after the administration of thorium dioxide changes with the passage of months or years. Some diminution in the opacity of the liver may occur, but the liver and spleen are still strikingly demonstrated as long as seventeen years later. Initially there is a diffuse homogeneous opacity; later this assumes a finely speckled appearance. The probable morphologic basis for this roentgen change in the liver is found in the distribution of the thorium dioxide. Soon after administration, granules of thorium dioxide are seen diffusely scattered in the Kupffer cells of hepatic sinusoids. The liver tissues examined after a number of years show clumping of thorium dioxide in portal fields, and this uneven distribution probably accounts for mottled shadows.

Another roentgen feature is the appearance of discrete, dense shadows in the region of the porta hepatis. This has been shown to be due to an accumulation of thorium dioxide in the lymph nodes draining the liver.

One roentgenogram; 3 photomicrographs.
HOWARD L. STEINBACH, M.D.
University of California

RADIOTHERAPY

Dose-Time Relationship for the Cure of Squamous Cell Carcinoma. J. Robert Andrews and Thomas O. Coppedge. Am. J. Roentgenol. **65:** 934–939, June 1951.

When the period of irradiation in the treatment of a squamous-cell carcinoma is prolonged beyond a single application, the cumulative effect of the subsequent irradiations is never fully additive.

The authors have reviewed the dose-time relationships as reported in the literature by various writers for treatment of squamous-cell carcinoma of the skin, cervix, larynx, and lip and have evolved a formula which they believe correctly expresses the dose-time relationship necessary for the cure of a squamous-cell carcinoma. In summary they state that "the concept of a constant dose-time relationship for the cure of squamous-cell cancer and the expression of this relationship by the equation $D = 3{,}200\ t^{0.22}$ [where D is total dose and t is time in days] seem valid. The value 3,200 for the dose constant seems to be established and the value 0.22 for the exponent appears to be confirmed by the data analyzed in this study." On a graph the plot would have a slope of 0.22, with dose the ordinate and time the abscissa.

In the practical application of the equation to the radiation therapy of squamous-cell carcinoma, the time in which a given treatment series could be administered would be determined, and the total dose necessary for the destruction of the tumor derived either from a graph or by means of the dose-time equation. The daily air dose required to attain this tumor dose could then be calculated.

This paper represents an attempt to convert the empirical conclusions of various clinical investigators to a valid numerical formula which will be valuable as a clinical aid.

One graph; 3 tables.
MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Experiences in the Treatment of Skin Cancer with Ultrasoft Roentgen Rays, 1933–1936. Erik Ebbehøj. Acta radiol. **36:** 17–27, July 1951.

An account is given of 208 cases of skin cancer treated with ultrasoft roentgen rays in the Radium Center for Jutland (Denmark). All diagnoses were microscopically verified. No patient had received previous treatment.

The technic is as follows: The ulcer and vicinity are cleaned with alcohol. No anesthetic is used, since local infiltration anesthetics cause swelling and increase the tumor thickness. A small biopsy specimen is taken. If it is not certain that the lesion is less than 1.0 mm. in thickness, it is scraped with a sharp curette and a compression bandage is applied. When oozing stops and the ulcer is dry, irradiation is applied. Even a thin layer of blood will prevent adequate penetration of the ultrasoft rays. Those tumors less than 1.0 mm. thick are irradiated with rays of h.v.l. 0.33 mm. skin, at 12 kv. If the thickness is between 1.0 and 2.0 mm., the h.v.l. should be 1.6 mm. skin, and the kilovoltage 26 kv. For tumors more than 2 mm. thick after scraping, a harder quality is used or a larger dose is given, evaluated in accordance with the supposed thickness. The ulcer is shielded with lead foil, leaving 6 to 8 mm. of normal skin exposed. A special shield is described for use in treating cancer of the eyelid.

With rays of 0.33 mm. skin h.v.l. the dose is 20,000 r, amounting to 3,000 r at 1.0 mm. depth and 500 r at 3.0 mm. depth; with h.v.l. 1.6 mm. skin, 5,600 to 6,000 r are delivered, giving 3,000 r at 1.6 mm. depth and about 1,800 r at 3 mm. depth. These doses are given in ten to twelve minutes.

Erythema appears on the normal skin in the irradiated area on the day of treatment. An exudative radioepidermitis develops, which heals in four to eight weeks. Healing occurs most rapidly on the face and more slowly on the body and lower extremities. The skin is left slightly atrophic, and inconspicuous scars remain, becoming less conspicuous with the years. These are more readily visible with radiation of 1.6 mm. skin h.v.l. than with the softer irradiation.

When the author started this method of treatment, 34 patients were underdosed. There were 11 failures in this group. In the remaining 174 cases metastasis to cervical lymph nodes occurred in 2 cases. The nodes were removed and the area treated with hard roentgen rays; there had been no further recurrences after more than five years. There were 6 local recurrences among the 174 cases.

A number of photographs show typical skin cancers and the good cosmetic results.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Results of Treatment of Skin Cancer with Ultrasoft Roentgen Rays Given in a Single Dose. Eyvind Mosekilde. Acta radiol. **36:** 28–34, July 1951.

The author discusses his experiences, at the Radium Center for Jutland, with Ebbehøj's method of treating skin cancer with ultrasoft roentgen rays given in a single dose (see preceding abstract). During the years 1937–42, 710 patients were treated for 777 malignant epithelial tumors. All cases were histologically verified. In 556 patients 603 tumors were treated exclusively with ultrasoft rays, h.v.l. 1.6 mm. skin, in one sitting. The use of such radiation is considered indicated when the tumor, after scraping, is between 1.0 and 2.0 mm. in thickness. The factors of irradiation are described in detail. Most of the patients received 5,100 r, measured in air on the skin surface.

Primary healing was accomplished in 96.8 per cent of the cancers. In the great majority of other cases, healing followed further treatment. Among the patients surviving at the end of the five-year observation period, the frequency of recurrence was 6.7 per cent; 22 of the 28 recurring cancers healed after renewed treatment. The remaining 6 patients showed no further recurrences at the end of the observation period but suffered discomfort from their lesions, and in 3 of these amputation of affected parts was done. One hundred and sixty-two patients died before the end of the observation period, 18 from cancer.

The calculated percentage of cure is 90.4 when the recurrences and deaths from cancer are considered. Recurrent lesions can be retreated successfully so that the possibility of absence of recurrence after the five-year period is approximately 97 per cent. About 94 per cent of the recurrences were encountered within the first five years. The percentage of recurrences increased with the diameter of the tumor. Most frequently, the cause of recurrence was that the irradiated field was too small, the recurring cancer appearing at the periphery of the previously involved area. It is, therefore, important to include a zone of 6 to 8 mm. around the tumor.

Three tables. BERTRAM LEVIN, M.D.
Chicago, Ill.

Case of Lymphoblastoma with Unusual Skin Tumefaction. Ernst A. Pohle and Marvin N. Golper. Wisconsin M. J. **50:** 559–562, June 1951.

Cutaneous involvement in lymphoblastoma is well known. It has been reported as occurring in about 24 per cent of patients with lymphosarcoma. Of these, something less than half have specific histopathologic changes in the skin lesions, the remainder being "id" (or toxic) reactions. The specific skin lesions may appear as plaques, nodules, or tumors, and often exhibit a "plum color."

The authors report a case of lymphosarcoma in a 71-year-old male, who had, in addition to swollen cervical lymph nodes, a dusky red, highly vascularized mass, 8 × 3 cm., on the left buttock. Biopsy of this mass showed it to be "lymphosarcoma, primitive cell type."

The patient received roentgen therapy to the cervical nodes and to the skin tumor on the left buttock, with prompt regression of the tumors. But the initial good response was soon followed by recurrence, which, in turn, responded temporarily to irradiation. After several courses of radiation, with progressively poorer response, death occurred from generalized disease eleven months after initial hospitalization.

The authors briefly discuss lymphoblastoma as to classification, clinical picture, pathology, and treatment.

Four illustrations, including 1 roentgenogram and 1 photomicrograph. SIDNEY KING, M.D.
Chicago, Ill.

Chromophobe Pituitary Adenomas: Surgical and Radiation Treatment. Gilbert Horrax. S. Clin. North America **31:** 877–881, June 1951.

In his discussion of the difficulties of decision as to whether irradiation or operation should be advised for the treatment of any given case of chromophobe pituitary adenoma, the author advocates a trial of preliminary radiation therapy in patients who do not have serious visual impairment. These patients may perhaps have bitemporal hemianopsia, with some pallor of the optic disks, but visual acuity is adequate for the performance of their usual duties. When, however, there has been serious loss of eyesight, and especially

when it has progressed to the point that the patient no longer has useful vision, the author believes it would be taking an undue chance to procrastinate several weeks with roentgen therapy, even admitting that in some cases of this kind vision has been greatly benefited by radiation.

The results as to visual improvement over periods of from two to eighteen years are given for the Lahey Clinic series of 105 verified chromophobe adenomas observed from 1932 through 1949. All patients had their tumors removed radically by a frontal craniotomy, with an over-all mortality of 13.3 per cent. Excluding those patients with large intracranial extensions of their adenomas, the mortality was but 3.9 per cent.

Improvement or preservation of vision, the primary concern in the treatment of pituitary adenomas, is evaluated in four treatment categories: surgery alone, surgery combined with irradiation, surgery after failure of irradiation, and irradiation alone.

Of 31 surviving patients treated with surgery alone, 24 of 27 (89 per cent) adequately followed showed improvement for varying periods. In 11 cases the improvement was maintained from five to eighteen years.

Of 60 surviving patients treated with surgery and radiation combined, 41 of 46 (89 per cent) adequately followed showed improvement comparable to that obtained with surgery alone. In 36 of these patients who had combined surgery and irradiation, operation became necessary because of the failure of radiation therapy to hold vision at a useful level. Twenty-three of the 32 survivors in this group were improved up to sixteen years after removal of their adenomas, with an average period of improvement of five and one half years.

Of 50 patients in whom only a clinical diagnosis was made, 27 had sufficient visual impairment to indicate radiation therapy. Of these treated with radiation, alone, about 60 per cent were either moderately or markedly improved.

J. FRANKLIN WALKER, M.D.
VA Hospital, Chamblee, Ga.

Metastasizing Adenoma of the Thyroid. H. Fetzer. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 426–434, April 1951.

The author describes the case of a 38-year-old woman who was observed by him for six years and in whom were discovered numerous metastases arising from an adenoma of the thyroid. The initial diagnosis was made on the basis of a biopsy of the left clavicle. The author considers at length the occurrence of metastases of adenoma malignum, reviews the literature, and discusses the therapy. He believes that both the primary tumor and the metastases should be irradiated.

Eight roentgenograms; 1 photograph; 1 drawing.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Primary Carcinoma of the Female Urethra with Metastases. J. S. Eisenstaedt. Am. J. Surg. **81**: 612–617, June 1951.

The author presents a review of carcinoma of the female urethra, with a report of 3 new cases. There are two types: vulvo-urethral carcinoma, arising in the vulva and spreading to involve the urethral meatus, and carcinoma arising in the urethra itself. Of the latter type there are two forms: the ulcerative, first manifesting itself as a malignant ulcer, usually in the floor of the urethra, and an indurative form, in which the carcinoma occurs primarily as periurethral induration. The author's cases were all of the latter type. True urethral carcinoma is less malignant and is less frequently encountered than the vulvo-urethral type.

The average age at the time of discovery of urethral carcinoma in the female is slightly more than 53 years. Squamous-cell carcinoma is more frequently seen, though adenocarcinoma and carcinomas of the mucoid, transitional-cell, and undifferentiated types also occur. Lymphatics are numerous about the urethra, with those about the distal two-thirds of the urethra draining into deep pelvic nodes. About one-third of the patients have enlarged inguinal nodes when first examined.

There are usually few symptoms early in the disease and for this reason the growth is often well advanced before treatment is sought. The most common presenting symptoms are: dysuria, hematuria, tumor at the urethral meatus, pain, frequency, and a watery urethral discharge. The diagnosis is easy in many cases, with proper examination. In some instances, however, other conditions must be carefully ruled out.

The author's first case was treated by the application of radium in a mold placed in the vagina (dosage not stated). This patient was followed for twenty-seven months without evidence of recurrence. The second case was treated by radium implantation about the urethra (dosage not stated) and was followed for thirty-four months before metastatic involvement of inguinal lymph nodes became evident. In the third case radium implantation about the urethra (1,635 mg. hr.) was followed by a course of roentgen therapy (1,700 r) to the region of the urethra. This patient had been followed for six months without evidence of recurrent disease. A brief discussion of the surgical treatment is also presented.

Six illustrations.

HENRY C. BLOUNT, JR., M.D.
University of Pennsylvania

Treatment of Wilms' Tumor. Carl Rusche. J. Urol. **65**: 950–963, June 1951.

The origin and histopathology of Wilms' tumor (adenomyosarcoma or embryonal carcinosarcoma of the kidney) are discussed briefly. A survey of the literature and some of the medical history of this disease are included.

The author reports 40 cases from his own material: 28 of the patients died and 12 were alive at the time of the report, 6 less than five years and 5 more than ten years. All of the survivors were treated with nephrectomy plus preoperative and/or postoperative irradiation; 20 of those who died received treatment comparable to the survivors.

The presenting symptom is usually an abdominal mass, although in 3 cases in this series the first symptom was hematuria, and in 2 cases pain. The author could find no correlation between the duration of symptoms before treatment and the prognosis. To be considered in the differential diagnosis are hydronephrosis, adrenal neuroblastoma, pyonephrosis, congenital polycystic kidney, and hypernephroma. Pyelographic studies are recommended for all children with abdominal tumor masses.

Cases have been reported as early as the seventh fetal month and as late as the eightieth year of life, but the vast majority of patients are under ten years of age. Sixty per cent of the author's cases were diagnosed before the third year of life. There were 21 males and 19

females in the series. One patient had bilateral involvement, and in one case the tumor developed four and a half years after the removal of an adrenal cortex tumor on the same side.

Metastases were present in 30 patients; 28 of these had died, 1 showed an adverse clinical course, and 1 appeared to be cured of a rib metastasis following a dose of 4,500 r. Bone metastases are rare: they occurred in 3 of the author's cases and in 5 cases from the literature.

The author believes in radiation as a preparatory procedure before nephrectomy and feels that the good accomplished far outweighs the loss of time involved in waiting four to six weeks for the effects of radiation to take place before surgery. He could find no relationship between the time elapsed from initial irradiation to surgery and the prognosis. The x-ray dose in his surviving cases ranged from 2,000 to 3,000 r preoperatively and from 1,200 to 5,640 r postoperatively. Factors of irradiation are not given.

The author was able to find a total of 72 reported five-year cures of Wilms' tumor. The therapy in these cases was: 43 per cent, nephrectomy only; 16 per cent, postoperative irradiation; 26 per cent, preoperative irradiation (half of this group also received irradiation postoperatively); 15 per cent, irradiation only. The statement made by others that a two-year survival after nephrectomy constitutes a cure was not confirmed. In 3 of the cases studied recurrence was observed after a longer period.

Six figures; 7 tables. ANTOLIN RAVENTOS, M.D.
University of Pennsylvania

Nasopharyngeal Irradiation. Relative Merits of Roentgen and Radium Therapy for Benign Conditions. L. H. Garland, H. A. Hill, M. E. Mottram, and M. A. Sisson. J. A. M. A. **146:** 454–460, June 2, 1951.

The authors review the distribution of lymphoid tissue in the pharynx and nasopharynx, emphasizing the absence of such tissue in and about the normal eustachian tube. In the presence of acute and chronic infection, however, lymphoid tissue may occur anywhere along the tube, being most prominent at the pharyngeal end. The normal air exchange between the middle ear and nasopharynx is said to be extremely slow, and, in the presence of lymphoid hyperplasia, mechanical block or compression of the pharyngeal end of the tube may result. Superimposed edema or infection may lead to aero-otitis, culminating in pain, tinnitus, vertigo, and nausea when a differential in excess of 30 mm. exists between the pressures in the middle ear and nasopharynx.

The treatment of choice for hyperplasia of the lymphoid tissue is irradiation. Both radium and roentgen rays have been used. The applicator commonly used for radium is made of monel metal with a wall thickness of 0.3 mm., an active length of 15 mm., and an outside diameter of 2.3 mm. Each holder contains 50 mg. of radium and is usually left in place for twelve minutes, for a dose of 600 mg. minutes to each side. At the surface of the applicator beta rays predominate but are largely absorbed at a depth of 1 cm., leaving the gamma radiation penetrating more deeply. Depth-dose tables indicate that extremely large doses, of the order of 4,450 r, are given the eustachian orifices, with proportionately little radiation reaching the other lymphoid tissue in the nasopharynx, the tubes, and the middle ear. This would indicate that for the usual patient having aero-otitis with deafness, who has generalized lymphoid hyperplasia, this method is not as good as for patients having localized lymphoid hyperplasia. It is emphasized that the large doses at the eustachian orifice exceed the radiation given for any other non-malignant condition.

The advantages of roentgen therapy lie in its simplicity and safety. No anesthesia is required, and the entire lymphoid-bearing area of the nasopharynx is homogeneously irradiated. The authors use 140 kv. with h.v.l. of 9 mm. Al or 200 kv. with h.v.l. of 1 mm. Cu, and a field measuring 6 × 7 cm., six treatments of 100 to 150 r in air being given to each side at weekly intervals. Fields are centered 1 to 2 cm. anterior to the inferior border of the tragus. Depth dose tables show less intense irradiation of the orifice and a more uniform irradiation of the lymphoid-bearing area.

Hendricks (see Ann. Otol., Rhin. & Laryng. **54:** 649, 1945. Abst. in Radiology **47:** 547, 1946) reported objective improvement in 65 and 90 per cent of Air Force personnel treated for aero-otitis with two and three radium applications, respectively. The authors, treating 720 cases of lymphoid hyperplasia with roentgen rays, obtained relief in 60 to 90 per cent with a single treatment.

There are no reports of damage from roentgen therapy in the doses specified and, with the field size recommended, no mouth dryness results. The disadvantages of radium include the uneven distribution of radiation and the danger to the operator in repeated applications, treatment of 3 patients weekly approaching the permissible tolerance dose to the physician's hands. Nor is radium treatment as harmless to the patient as is generally held. There have been cases of radium ulcers of the posterior nasopharynx. Late changes must also be considered. In the opinion of the authors, roentgen therapy is the treatment of choice.

Four figures; 5 tables.

WALTER M. WHITEHOUSE, M.D.
University of Michigan

Treatment of Hypertension (Unsuccessful with Roentgen Irradiation of the Carotid Sinus). D. Loos. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 721–724, June 1951. (In German)

In most hypertensive conditions a central nervous system disturbance is present; accompanying factors may be chronic kidney inflammation or infection, prolonged nervous stress and strain, toxic, allergic and endocrine disturbances. Operation on the carotid sinus with novocain block has been recommended on the basis of relationship between the carotid sinus, vagus, sympathetic, and mid brain. The method has apparently been found of value in the occasional case but has been severely criticized as a means of relieving hypertension routinely. Bromides and barbiturates have been widely used without consistent results. X-ray treatments of the adrenals and mid brain, including the pituitary, have been used by many authors, particularly the Russians.

X-ray therapy of the carotid sinus was first recommended for hypertension in 1932, by a Spanish author, name unknown, and was used by Flipo in 1947 (Ref. Congress Zentralbl. **118:** 315, 1948). The present author in using this method has seen no untoward results but has been able to come to no definite conclusions as to its value. Forty cases have been treated over a period of two years, with essential hypertension ranging above 200 mg. Hg. The factors were

145 kv. p., 20 ma., 3 mm. Al filter, 30 cm. focal skin distance; dose 100 r (on the skin). Treatments were repeated monthly as indicated. The author states that he saw no difference in results in cases in which both sides were treated as compared with those treated on only the left side. There was apparently a temporary reduction of systolic pressure by 30 mg. Hg, but this degree of variation is often seen in elderly patients without treatment. No subjective improvement was reported.

It is concluded, therefore, in contrast to the statements by Flipo, that irradiation of the carotid sinus has not proved of value. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Role of Radiation Therapy in Pediatrics. Paul H. Reitman. Arch. Pediat. **68**: 265–273, June 1951.

Of 1,728 new patients seen in the department of Radiotherapy of Michael Reese Hospital (Chicago) in a twelve-month period, 25.2 per cent were children up to fifteen years of age, and of these 4.8 per cent were suffering from malignant neoplasms.

In the bulk of the benign cases treatment was for hyperplastic lymphoid tissue. The patients thus treated (46 per cent of the benign group) were considered too young for surgery, had allergies or rheumatic heart disease, or had not had a period free from infection long enough to permit surgery. Of the 203 children, 70 per cent received adequate relief from symptoms, so that for all practical purposes they were considered well; an additional 16.6 per cent showed temporary improvement, and 13.3 per cent were not benefited by irradiation.

Of the remaining benign lesions, 150 were vascular nevi. Treatment in these cases is usually started at about three months of age, since some nevi may regress spontaneously by that time. The results of treatment are not discussed. Other benign conditions treated included selected inflammatory dermatitides, cellulitis, furunculosis, sinusitis, otitis media, thrombophlebitis, pneumonitis, neuritis, gas gangrene, and vernal catarrh.

The author particularly stresses the fact that in thymic enlargement irradiation is only indicated when it can be demonstrated on roentgenograms that the obstructive symptoms are due to the enlarged thymus compressing the trachea. This happens infrequently as compared with the number of times the thymus is visible on the chest films.

Five graphs. BERTRAM LEVIN, M.D.
Chicago, Ill.

RADIOISOTOPES

Determination of Circulation Factors with Radioactive Substances (Radiocirculography). P. Waser and W. Hunzinger. Schweiz. med. Wchnschr. **81**: 216–221, March 3, 1951. (In German)

Studies of the circulation by means of a radioactive isotope were made in some 600 persons, including normal subjects, as well as those with circulatory disorders. Radioactive sodium chloride (Na^{24}, half life 14.8 hours) was injected into the right cubital vein in amounts of 0.2 to 0.3 millicuries, and measurements were made with Geiger-Müller tubes over the heart region, the left wrist, and right and left ankle areas. The radiation activity was plotted in the form of a curve as a function of time (from one to thirty seconds).

The normal curve is explained in detail and changes due to various pathological conditions of the heart or circulatory system are discussed. Several case reports are included. Characteristic curves are obtained in thyrotoxicosis, mitral and aortic insufficiency, decompensated hypertension, lung tumors, and other conditions.

For the study of disturbances of the peripheral arterial system, the radioactive sodium chloride was injected directly into the artery.

The authors point out that the method is also useful in comparative studies to evaluate the effects of drugs used in the treatment of heart and blood vessel diseases. The examination is without danger, it is simple to do, and is without inconvenience to the patient. Interpretation of the curves in a given case can be made only with the exact knowledge of all the clinical data.

Ten curves; 1 table.
EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

Radioactive Isotopes and Malignancy. Richard H. Chamberlain. Pennsylvania M. J. **54**: 550–553, June 1951.

When radioactive isotopes became available following the wartime development of atomic energy, it was hoped that because of their use a great deal of progress would occur in the management of cancer. The results have thus far been disappointing. There has, however, been progress in two major directions. In the first, the field of research, the use of isotopes in the tracing of biochemical processes at the cellular level has opened up a whole new frontier of study of intermediary metabolism and the perversion of cellular metabolism in cancer. In the second, the clinical management of cancer, advance has been less rapid.

In perceiving both diagnostic and therapeutic potentialities of isotopes, three basic features must be understood: (1) ionization—the common denominator of all radiation action; (2) the characteristics of the radioactive isotopes and their emissions; (3) biological concentration factors.

Because ionization is the common denominator of all radiation it is self-evident that no new curative phenomenon would result from the use of radioactive isotopes. The types of emissions—alpha, beta, and gamma rays—are also known, as are the possibilities of their use in treatment. It is, therefore, upon the basis of concentration factors that we may continue to hope for sufficient return in therapeutic usefulness to pursue the clinical applications of radioactive isotopes.

One of the most widely known instances of biological concentration is seen in the unique avidity of the thyroid for iodine, but though a suitable radioactive isotope of this element is readily available, the results of treatment in cases of cancer have been disappointing. Only 10 per cent of the cases are suitable for treatment, and sufficient concentration for eradication of the tumor seldom occurs.

Phosphorus^{32} has been used with good effect in the treatment of polycythemia vera, and is of some aid in the management of chronic myelogenous leukemia. It cannot be of great benefit in the treatment of bone metastasis because critical levels of depression of

normal bone marrow activity may not be exceeded without fatal results, and only high concentrations will cause a regression of the tumor.

Radioactive gold, colloidal radioactive phosphate, and a few other colloidal radioactive isotopic forms are being studied, and their use will become more definitely determined by further study. The author also mentions radioactive cobalt for beam radiation as a substitute for two-million-volt installations but at the time that his paper was presented there was some question as to the practicability of this application [see, however, Cobalt^{60} as a Source for Radiotherapy, Editorial, Radiology **58**: 113, 1952].

It is concluded that no advantage is to be gained by making unwarranted predictions about the importance of isotopes in the treatment of malignant neoplasms. It is to be hoped, however, that new advances in the field of biochemistry may widen the scope of their usefulness.

One table. JOSEPH T. DANZER, M.D.
Oil City, Penna.

Hyperthyroidism Without Apparent Hypermetabolism. Sidney C. Werner and Howard Hamilton. J. A. M. A. **146**: 450–453, June 2, 1951.

The use of newer technics, including radioiodine tracer uptake and determination of serum precipitable iodine, brought about the recognition of a hitherto poorly recognized group of patients having hyperthyroidism without elevation of the basal metabolic rate. Differentiation of this entity from anxiety states is difficult, and a definite response to therapy is required before a final diagnosis of hyperthyroidism without apparent hypermetabolism is accepted.

Analysis of data on 15 patients, 6 of whom had no previous treatment, varying in age from twenty-one to sixty-one years, is presented. The most consistent symptoms were nervousness (11), weight loss with good appetite (10), palpitation (8), and fatigability (8). The one physical finding consistent in all was tachycardia, with extended hand tremor in 9 and warm moist palms in 5. The average basal metabolic rate before treatment was plus 11 (range plus 1 to plus 16), average blood cholesterol 176 mg./100 c.c. (range 111–249), average radioiodine uptake 55 per cent at 24 hours (range 38–77), and average serum precipitable iodine level 13.1 gamma/100 c.c. (range 9.3 to 25.9). The radioiodine uptake and serum precipitable iodine determinations were higher than the usual normal, although the lower limits of the range overlap the extreme upper limits found in some euthyroid patients.

After treatment in 14 patients, consisting of radioiodine in 6, propylthiouracil in 5, surgery in 1, and sodium iodide in 2, there was an average weight gain of 7 lb. (range 3–14); the average basal metabolism rate was plus 6 (range minus 18 to plus 8), average cholesterol 234 mg./100 c.c. (range 181–371), and average serum precipitable iodine level 7.2 gamma/100 c.c. (range 5.6 to 8.9). Subsidence of symptoms and signs of hyperthyroidism was observed.

The authors note that in addition to radioiodine uptake and serum iodine determinations, a therapeutic trial of sodium iodide may aid in selecting patients who will respond to treatment. Two additional cases are reported with laboratory findings consistent with hyperthyroidism but with lack of response to treatment.

The awareness of the existence of hyperthyroidism without apparent hypermetabolism is important because of the possibility of residual borderline toxicity after treatment of thyrotoxicosis if basal metabolic rate alone is relied on for evaluation.

Five tables. WALTER M. WHITEHOUSE, M.D.
University of Michigan

Thigh-Neck Clearance. A Simplified Radioactive Test of Thyroid Function. J. B. Foote and N. F. Maclagan. Lancet **1**: 868–871, April 21, 1951.

The authors describe a new test of thyroid function, which depends on alternate neck and thigh counts after oral administration of 30μc of I^{131}. It was known from previous work that changes in thyroid function are reflected in these counts, the neck uptake increasing and that of the thigh decreasing as one passes from myxedema to thyrotoxicosis. By dividing the rate of uptake in the neck (expressed as increase of neck counts per hour) by the thigh count, a factor is obtained which is designated the thigh-neck clearance. The measurements are made at the time of the maximum thigh count, which will usually be reached within an hour of ingestion of the I^{131}. The procedure takes about one and a quarter hours. Simultaneous thigh and blood radioactivity estimates indicated a good correlation between the two at the time the test is performed.

The thigh-neck clearance gave readings from 1 to 9 in normal subjects, from 21 to 108 in thyrotoxicosis, from 1.5 to 11.5 in non-toxic goiter, from 0 to 0.8 in myxedema, from 1.5 to 14.2 in miscellaneous diseases including cases of questionable toxicity, and from 11 to 63 in patients undergoing treatment with thiouracil and similar preparations.

The thigh-neck clearance showed changes similar to those obtained in plasma-iodide clearance studies in abnormal thyroid states. It is superior to the neck-thigh ratio in the diagnosis of myxedema.

Nine illustrations.

Treatment of Multiple Myelomata with Radioactive Phosphorus. E. Lindgren, I. Bergström, and G. Wihman. Acta radiol. **36**: 49–61, July 1951.

The authors discuss the use of radioactive phosphorus in the treatment of multiple myeloma and present 4 cases so treated. In each instance there was prompt alleviation of pain even where diffuse bony destruction had occurred.

In each case the diagnosis was confirmed by bone marrow study as well as by other laboratory and clinical studies. The average age was sixty years. The diagnosis was known for about two years in 3 patients and for about four years in the fourth.

The radioactive phosphorus, in the form of Na_2HPO_4, was administered orally in a glass of 10 per cent glucose solution upon an empty stomach, in an amount varying between 1.5 and 4.0 millicuries. The drug was repeated when pain recurred. Not only was pain controlled but the lassitude present in each instance was decreased. No side reactions were observed.

Bone marrow changes were evident in each case and included decrease in the plasma cell elements and decrease in number of immature and multinuclear cells. Nucleoli became irregular and bizarre, and the chromatin underwent disintegration. The cytoplasm became vacuolated. There was no evidence of damage to the bone marrow in the form of accentuation of the anemia, granulocytopenia, or thrombocytopenia. There was a definite tendency of the sedimentation rate to fall.

The destructive processes in the bone were not affected; their progress continued unretarded.

The use of nitrogen mustard, stilbamidine, and urethane in the treatment of multiple myeloma is discussed, and the disappointing results and many side effects are noted. While others have reported less favorable results with radioactive phosphorus, the authors feel that the marked subjective relief experienced by their patients warrants continuation of its use in multiple myeloma.

Six photomicrographs; 6 graphs.

BERTRAM LEVIN, M.D.
Chicago, Ill.

Radioactive Cobalt as an Adjunct to Cancer Surgery. Arthur G. James, Roger D. Williams, and Joseph L. Morton. Surgery **30**: 95–105, July 1951.

The applicability of cobalt^{60} sources in nylon tubing for interstitial irradiation of inoperable malignant growths is described and illustrated by several case reports. The advantages of cobalt in this form in treatment of head and neck tumors are: (1) it conforms better to irregular masses of tissue than needles; (2) it is associated with less morbidity in the vicinity of bone than radium; (3) it can be used effectively in situations where skin tolerance to external irradiation is lost.

In inoperable tumors in the abdomen which are radioresistant, a rather heavy and uniform dose can be achieved which might not otherwise be obtained. Similar advantages are listed for treatment of certain lesions of the mediastinum and extremities.

The physical, technical, and economic considerations which qualify this form of radiotherapy for further application in the treatment of malignant disease have been more fully discussed previously (Radiology **56**: 553, April 1951). This report is concerned more particularly with clinical indications in an effort to acquaint the surgeon with the potentialities of the method.

Two roentgenograms; 7 photographs; 6 sketches.

JOHN F. RIESSER, M.D.
The Henry Ford Hospital

Radioiron Studies in a Case of Hemochromatosis. T. Alper, D. V. Savage, and T. H. Bothwell. J. Lab. & Clin. Med. **37**: 665–675, May 1951.

The authors present a series of radioiron studies in a patient suffering from hemochromatosis and showing myocardial failure, sexual hypoplasia, and hepatic enlargement.

The patient was given 34 mg. of radioiron orally for the purpose of determining the fate of dietary iron, Radio assays were made to determine excretion in the feces and urine over the first seven days after administration. External counting measurements were obtained over various organs, as well as assays of radioiron uptake in blood samples taken at regular intervals and assays of liver biopsy material. Postmortem, a limited assay of various organs was done. Control measurements were made in a healthy, normal individual who was given the same volume of the radioiron solution as the patient.

The results of this study indicated that a large percentage of the radioiron was taken up by the patient and retained in the body. The blood iron studies indicated that at the end of six days 1.4 per cent of the administered dose was circulating in the blood, and this figure gradually rose to a maximum of 4 per cent after 100 days. In addition, a large portion of the radioiron was deposited in the liver, estimated as about 30 per cent of the administered dose after five months. A considerable amount of radioiron was also deposited in the heart, as external counting over this area was almost three times as high as in the control subject. There was no correlation between the amount of iron deposition and the degree of myocardial failure. Varying amounts were found to be present in all of the organs examined postmortem.

According to the authors, this study is in contrast to the studies of others in respect to the uptake of radioiron in the blood. It is suggested that the increased iron absorption in hemochromatosis may be related to pancreatic damage as an initiating factor. The authors indicate that this possibility invites study with tracer doses of radioiron.

One photomicrograph; 4 tables; 4 charts.

HERBERT D. KERMAN, M.D.
Oak Ridge Inst. Nuclear Studies

Urinary Excretion of Gallium by Man and Animals. J. I. Munn, N. H. Walters, and H. C. Dudley. J. Lab. & Clin. Med. **37**: 676–682, May 1951.

The authors describe a method for the separation of gallium from urine by ether extraction of a 6 *N* HCl solution. Colorimetric or fluorometric estimation of 8-hydroxyquinoline-gallium complex in chloroform is used as a basis for quantitative determination.

The influence of dose and route of injection (intravenous or subcutaneous) on the urinary excretion of gallium was studied in the rabbit and dog, and it was found that intravenous injection promotes greater retention of the parenterally administered gallium citrate, with lessened urinary excretion.

A study was also made of gallium excretion and blood levels in 22 patients with neoplastic bone lesions receiving Ga^{72} with gallium citrate as the carrier. The observations varied widely, and the authors felt that this might reflect the degree of pathologic bone involvement, which may influence the amount of gallium retained. However, these were only preliminary studies and were not definitive.

The initial excretion rate of Ga^{72} is high in both dogs and man, and reaches a low level in less than eighteen hours, which parallels the gallium content of blood following intravenous injection. The blood gallium level falls rapidly after intravenous injection and approaches low values within six hours.

HERBERT D. KERMAN, M.D.
Oak Ridge Inst. Nuclear Studies

RADIATION EFFECTS

Radiation Damage to Normal Tissues in the Diagnosis and Treatment of Nonmalignant Conditions and Its Surgical Repair. Ernest M. Daland. New England J. Med. **244**: 959–964, June 28, 1951.

This article should be read by all radiologists and especially by young radiologists in training. The cases cited in illustration of damage to normal tissues incident to roentgen diagnosis and radiation therapy of benign conditions are a striking commentary on the failure of appreciation of the long-term effects of radia-

tion. The possibilities which they represent should be kept constantly in mind by the radiologist irradiating or talking about irradiating normal structures.

The author repeats the well known admonition that repeated doses of low-voltage therapy may result in permanent damage to the tissues and even in the development of cancer.

As to the treatment of the damaged tissues, removal should be as extensive as possible, down to normal structures. When loss of fat has occurred, thin skin grafts are less satisfactory than pedicle grafts containing fat. Wounds should never be left open to granulate. If there has been deep destruction down to fascia, periosteum or bone, a healthy base may be unobtainable. If the skin and fat of the periphery are normal, it is possible to rotate a pedicle flap to cover such a wound, even though the base is very bad. Nourishment to the flap is furnished from the skin edges. Gradually the flap will adhere to the underlying tissues.

Two roentgenograms; 9 photographs.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Fibrosarcoma of the Tongue After Interstitial Irradiation. Report of a Case. Peter Deller. Lancet **1**: 1159–1160, May 26, 1951.

A case is reported in which a fibrosarcoma of the tongue developed nineteen years after interstitial irradiation at the same site.

The patient was first seen in October 1929 with a lump under his tongue and an ulcer measuring 2 × 1.5 cm., with hard, raised, everted edges on the left side of the undersurface of the tongue, extending into the floor of the mouth. The base of the ulcer was indurated, but the induration did not extend appreciably beyond its edges. No nodes were palpable in the neck. A diagnosis of carcinoma was made (no biopsy), and the growth was treated with interstitial radium in a total dosage of 1,210 mg. hr. or about 10,000 r. Two weeks later the nodes of both submaxillary triangles were dissected and a year later a formal left block dissection was performed. None of the nodes showed carcinoma, and the growth regressed satisfactorily. The patient was seen regularly for nearly nineteen years. In September 1948 he noticed another lump in his tongue. Deep to the irradiation scar was a firm, irregular, ill-defined mass 1.5 cm. in diameter. No masses were palpable in the neck. A left hemiglossectomy was performed. On section a fibrosarcoma of low-grade malignancy was reported. There was no evidence of recurrence twenty-seven months later.

Without histologic proof it is impossible to say whether the original growth was a sarcoma or a carcinoma. If it was a sarcoma, its clinical features were atypical and its local recurrence after nineteen years was most unusual. On the other hand, the development of sarcoma following interstitial irradiation, though not unknown, is so rare that it is impossible to be certain whether in this case there was any causal connection between the irradiation and the tumor.

Lipoid Pneumonia (Non-Inhalation) in Carcinoma of the Lung Treated by Radiotherapy. S. J. De Navasquex, J. R. Trounce, and A. B. Wayte. Lancet **1**: 1206–1208, June 2, 1951.

Lipoid pneumonia is usually due to the inhalation of mineral or vegetable oil which irritates the pulmonary epithelium, producing fibrosis. Although fibrosis in the lungs after irradiation has been fully described, the possibility of lipoid pneumonia resulting from irradiation seems to have been overlooked.

A case is reported in which lipoid consolidation of the lung was found after a pulmonary carcinoma had been treated by deep roentgen therapy (tumor dose 4,000 r, in twenty-eight days). The patient died about twenty weeks after the irradiation.

The most conspicuous feature of the pulmonary consolidation was the intracellular lipoid, which was confined to the irradiated areas of both lungs, corresponding to the extent of the opacity shown roentgenographically. Inhalation of fatty material was excluded, so one must assume that the lipoid was endogenous. The demonstrable fat may then have been due to phanerosis and unmasking of lipoid substances normally present in pulmonary parenchyma and carcinoma, or to infiltration into injured cells rendered incapable of metabolizing it. Four non-irradiated cases of carcinoma of the lung have shown similar changes. The fatty change is thought to be due to degeneration of the carcinoma and of the adjacent lung parenchyma. In the case reported the process is believed to have been accelerated by deep roentgen therapy.

Seven illustrations, including 3 roentgenograms.

Late Complications Following Irradiation of Pelvic Viscera. William Crawford White and Frederick Wall Finn. Am. J. Obst. & Gynec. **62**: 65–74, July 1951.

Ewing (Am. J. Roentgenol. **15**: 93, 1926) attributed bone lesions following irradiation to obstruction of the lacunae and vascular channels in the haversian and Volkmann's canals, with osteoporosis secondary to vascular absorption and osteoplastic activity. This produces brittle bones, more subject to fracture. Spontaneous fracture occurs in about 1 per cent of cases after pelvic irradiation, and there is often prodromal pain. The bone most often affected is the neck of the femur. Fractures of the pubis occur less often. Treatment is conservative or by internal fixation, according to the degree of displacement.

Post-irradiation urinary tract complications following pelvic irradiation are commonly indolent ulcers of the bladder, vesicovaginal fistula, and intramural ureteral stricture with secondary hydroureteronephrosis. These may not become manifest until years after treatment. Cystoscopy and pyelography are urged prior to irradiation and at regular intervals thereafter for the detection of urological disease and the early recognition of urinary tract damage to permit treatment before the condition has become advanced.

The incidence of permanent post-irradiation damage to the rectum, sigmoid colon, and ileum is variously estimated as 17 to 75 per cent of cases thus treated. The pathologic process is thrombosis of the vessels, necrosis of the mucous membrane with fibrosis of the wall of the intestines, and secondary contracture of the lumen. Ulcerations may erode into large vessels, causing massive hemorrhage, or through the bowel wall causing perforation and peritonitis. Contracture may cause partial or complete obstruction. Many cases can be treated conservatively, but constant and careful observation is necessary, as the pathological processes are progressive, and the danger of perforation or hemorrhage may make elective surgery preferable.

The administration of antibiotics prior to radiation

therapy is believed to decrease the urinary and intestinal morbidity.

Six roentgenograms; 1 table.

MASON WHITMORE, M.D.
Jefferson Medical College

Further Studies on Recovery from Radiation Injury. L. O. Jacobson, E. L. Simmons, E. K. Marks, E. O. Gaston, N. J. Robson, and J. H. Eldredge. J. Lab. & Clin. Med. **37**: 683–697, May 1951.

The authors report further studies of recovery from radiation injury in a series of animal experiments involving spleen implantation and shielding of the spleen, liver, intestines, kidneys, head, and leg. The effects of splenectomy and delayed implantation of the spleen on post-irradiation damage were also studied, and comparative observations were made on the effect of spleen shielding in mice receiving nitrogen mustard.

The authors' summary and conclusions are as follows:

"The LD 50 per twenty-eight days for spleen-shielded mice is circa 1,100 r whole blood x-radiation compared to circa 550 r for mice without spleen shielding. Intact mice rarely survive 800 r whole body x-radiation. Only 1.1 per cent survive 1,025 r whole body exposure without spleen shielding.

"Recovery of hematopoietic tissue as well as the recovery of the gastro-intestinal tract is significantly hastened by spleen shielding. Lead shielding of part of the exteriorized liver, the exteriorized intestine, or the entire head or the hind limb enhances survival of animals exposed to 1,025 r whole body x-radiation, but not to the extent observed with spleen shielding. Shielding of a single kidney during exposure to this dosage does not enhance survival.

"The survival of mice in which the circulation of the shielded spleen is clamped off during exposure of the animal to 1,025 r and the clamp is released immediately thereafter is approximately the same as the survival in the regular procedure of spleen shielding only.

"Surgical extirpation of the shielded spleen at intervals after the shielding procedure indicates that a beneficial effect has been exerted even if the spleen has been left intact in the circulation for one hour. The survival of animals exposed to 1,025 r with spleen shielding and subjected to splenectomy from one to forty-eight hours later is between 39 and 85 per cent for the twenty-eight-day period of observation.

"Transplantation of one to four fresh spleens from young mice into the peritoneal cavity of mice immediately after exposure to 1,025 r whole body x-radiation significantly increases the survival of the irradiated mice. Similar transplantation of spleens into irradiated mice two days after whole body exposure to 1,025 r x-radiation likewise enhances survival but is definitely not as effective.

"These facts indicate that unlike glutathione, cysteine, oxygen deprivation, or cyanide intoxication, the 'factor' in spleen shielding which effects a significant increase in survival of mice from whole body x-radiation is unnecessary during the actual irradiation process and is definitely effective after irradiation.

"In the experiments described, the general assumption is either that (1) the shielded tissues produce a substance of a noncellular nature which exerts a beneficial effect on the recovery of the irradiated animal or (2) that cells migrate from the shielded tissue which enhance recovery of the irradiated tissues. The evidence appears to be in favor of the first assumption, but both may be wrong. The possibility has not been eliminated that irradiation of tissue produces a 'toxin' and that the shielded tissues or implanted tissues in some way exert a detoxifying action as the 'toxin' courses through the shielded tissues."

The authors also briefly discuss the relationship of these observations to radiation injuries.

For those interested in these experiments, direct reference to this paper is suggested for the details of the experimental methods and results.

Seven tables.

HERBERT D. KERMAN, M.D.
Oak Ridge Inst. Nuclear Studies

Production of Hypochlorhydria by Beta Radiation of the Stomach. D. M. Douglas, W. R. Ghent, and S. Rowlands. Lancet **1**: 492–495, March 3, 1951.

The gastric mucosa of dogs was irradiated with beta rays from an intragastric balloon containing P^{32}. Exposure was maintained until the mucosa had absorbed energy equivalent to 5,000 r (though the authors state that it does not follow that the biological effect of this dose is the same as that of 5,000 r of x-rays). Gastric secretion was studied before and after irradiation. Seven dogs were used in the investigation.

After irradiation all the dogs showed a reduction in both the free hydrochloric acid and the total acid in the gastric juice. One dog was sacrificed at 87 days because it was found to have a thick band of fibrous tissue encircling the body of the stomach, probably due to excessive irradiation. Five dogs had been followed 85 to 109 days. The other dog was still under observation at 241 days, at which time the hypochlorhydria persisted. After irradiation all the dogs lost weight (5.7 to 0.9 kg.). At the time of the report all the surviving animals were in good health, and their food intake was normal. At laparotomy the adjacent organs appeared normal in every dog.

The duration of the induced hypochlorhydria, the best dosage of beta radiation, and the possibility of late carcinogenesis are being investigated.

Six figures.